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ABSTRACT

This report describes a project in Utah to investigate the feasibility of using transient evoked otoacoustic emissions (TEOAE) as a tool for screening for hearing loss in children with developmental disabilities (DD). Study participants included 336 students (ages 5 to 7) with no identified DD and 765 students (ages 3 to 7) with one or more DD. Each participant was screened using two conventional pure tone hearing screening protocols and two TEOAE hearing screening protocols. The study found that, overall, the operant characteristics of one of the conventional hearing screening protocols (which used tympanometry screening for the 500 Hz pure tone) were superior to the other measures. However, for nearly one-third of the children with DD, screening results could not be obtained from either of the pure tone screening protocols, whereas successful results were obtained for over 98 percent of the same children using the TEOAE screenings. Results also supported previous findings of a substantially higher incidence of hearing loss in children with DD. The report addresses the project's importance, purpose, accomplishments, methodology, and results. Extensive appendices include necessary approvals for use of human subjects; data collection schedules and summary sheets; a consultant's report; a listing of data dissemination activities, and a summary of participant data. (Contains 59 references.). (DB)

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The Efficacy of Evoked Otoacoustic Emissions in Identifying Hearing Loss in Children with Developmental Disabilities

[Award Number: HO 23C 30039]

by

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ABSTRACT

Statement of the Problem

Research suggests that as many as 78% of children with developmental disabilities (DD) in the United States have a mild to profound hearing loss. Many of these children remain undiagnosed or misdiagnosed for years because they are difficult to test using traditional audiometric methods. They are the 'silent sufferers' in our educational system. The difficulties encountered in performing audiometric assessments for children with DD in an educational setting are often compounded by the lack of an appropriate assessment environment, the absence of specialized equipment, and the costs of making appropriate referrals. The value of educational and therapeutic programs for children with disabilities and a concomitant hearing loss is severely impaired, if the hearing impairment is not correctly identified and treated.

Project Goals

The goal of this project was to investigate the feasibility of using transient evoked otoacoustic emissions (TEOAE) as a tool for screening for hearing loss in children with already confirmed DD. Further, this project compared the efficiency and test operating characteristics of TEOAE to conventional hearing screening protocols using pure tone and immittance tests.

Methodology

Study participants included 336 students between the ages of 5 and 7 who have no identified DD and 765 students between the ages of 3 and 7 who have one or more DD. Each participant was screened using the two conventional hearing screening protocols and the state-of-the-art hearing screening protocol for TEOAE. The conventional hearing screening protocols were those outlined by the American Speech-Language-Hearing Association. In this

study, these two screening protocols were called Asha-A and Asha-B. The Asha-A protocol screens each ear for hearing loss at 20 dB HL with pure tones of 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz. The Asha-B protocol follows the Asha-A protocol, but substitutes tympanometry screening for the 500 Hz pure tone. The auditory status for each participant was determined using a battery of tests including both objective and behavioral audiometric measures. Operant characteristics of the hearing screening protocols were then evaluated using the audiometric status as the golden standard.

Results

The operant characteristics of the Asha-B hearing screening protocol were superior to both the Asha-A hearing screening protocol and the two TEOAE screening protocols for both groups of subjects. However, for the group of children with DD, screening results could not be obtained from nearly one third of the children with DD using either of the pure tone screening protocols, whereas successful results were obtained from over 98% of the same children using TEOAE screenings.

Conclusions

TEOAE hearing screenings provide a useful alternative for identifying children with DD who need further audiological assessment, particularly for those children for whom conventional hearing screening protocols cannot be completed. TEOAE hearing screenings are highly sensitive to peripheral auditory pathology, are easily completed in educational settings, and are not dependent on behavioral responses from the person being screened.

IMPORTANCE

Hearing Impairment: The Scope of the Problem

Until recently, statistics have supported the figure of one child per 1000 being born deaf; an additional two children per 1000 are deafened during childhood (Coplan, 1987), and an equal number suffer from permanent, partial hearing loss of disabling proportions (Bergstrom, Hemenway, & Downs, 1971; Schein & Delk, 1974; Simmons, 1980). More recently, hospital-based universal neonatal hearing screening programs are reporting that, on average, three to four infants per thousand have some degree of permanent hearing loss (National Consortium for Newborn Hearing Screening, 1995). The incidence of deafness in populations of children who are born prematurely or otherwise at risk is 20 to 35 times higher than that of normal-term healthy infants (Dennis, Sheldon, Toubas, & McCaffee, 1984; Sanders et al., 19985; Thompson & Folsom, 1981). In addition, increasing numbers of children are experiencing hearing impairment as a result of infections, high fevers, and otitis media (Clark, 1989; Morgan, 1987). According to the Fourteenth Annual Report to Congress on the Implementation of the Individuals with Disabilities Education Act (IDEA), approximately 13 in every 10,000 children require special education services as a result of hearing impairments (U.S. Department of Education, 1992). Although the number of children with significant hearing loss is rising, this number is down from the 1988 report from the U.S. Department of Education that indicated 16 children per 10,000 required special education services due to hearing loss.

Medical factors have a strong influence over prevalence figures for hearing loss, causing great fluctuations. For example, an epidemical disease, such as rubella, may result in high numbers of children deafened in one year, and relatively few the next (Jensema, 1974). Recent

medical discoveries have also increased the number of individuals with hearing loss by increasing survival rates for certain pathologies associated with auditory pathology. For example, before the discovery of antibiotics, bacterial meningitis was often fatal. However, since antibiotics have become widely available, patients frequently survive the disease, but are often left with impaired hearing (Delage & Dusseault, 1979). Similarly, the survival rate for low birth weight/premature infants has doubled over the past two decades. Approximately 20% of the low birth weight/premature survivors are diagnosed as having one or more disabilities (Bennett, 1984). Estimates of significant hearing loss in this group of neonates range from as low as 1% to as high as 17.5%, with most studies finding averages between 3% to 5% (Schulman-Galambos & Galambos, 1979; Schulte & Stennert, 1978; Moore, Thompson, & Folsom, 1992). Social-medical factors such as the dramatic increase in several types of sexually-transmitted diseases that cause hearing impairment (e.g., syphilis) in infants of infected mothers is another trend which may significantly increase the numbers of children with hearing loss (Vernon & Hicks, 1980).

Occurrence of Hearing Impairment in Conjunction with Other Disabilities

A substantial proportion of children have hearing impairment in addition to cognitive or physical disability. Most additional handicaps occur among those children whose hearing impairment has been caused by illness (e.g., cytomegalovirus, maternal German measles, bacterial meningitis) or injury, because damage from such causes may also harm some other part of the brain or body (Ling, 1984). For example, German measles can also cause heart and eye defects, and meningitis may cause brain damage and vestibular or balance disorders. Children whose deafness is genetic in origin tend to have fewer additional disabilities than those whose hearing problems have been caused by various infections (Ling, 1984; Vernon & Andrews, 1990).

The frequency of other developmental disabilities (DD) is higher among children with hearing impairments as compared to the population at-large (Coplan, 1987; Schein & Delk, 1974). Not surprisingly, hearing impairment is also more common among children with DD than children with no disabilities (Coplan, 1987). For instance, the prevalence of deafness among children with severe mental retardation or cerebral palsy is 10% to 15% (Conley, 1973; Vernon, 1970) versus four to five per 1000 among otherwise normal children. Despite the known increased prevalence of hearing loss among children with disabilities, in a review of records of approximately 1,000 children seen for evaluation of DD, Coplan (1987) found that most children were in therapy programs for their coexisting DD for months, or even years, before the first audiogram was obtained. As examples, three children with severe congenital hearing impairments were presented. Each child had been participating in programs for the mentally retarded since infancy and the children were not correctly diagnosed with hearing loss until 6, 11, and 17 years of age. Coplan concluded that the existence of undiscovered hearing losses in children with other handicaps is a widespread problem which is substantially impairing the effectiveness of educational and therapeutic programs for those children.

One reason for delayed identification, or even undiscovered hearing loss, is that physicians mistakenly attributed the child's speech delay solely to the associated DD. Comments in the medical record such as "the child does not speak because he is retarded" were typical in the Coplan (1987) study. Another study highlighting the delay in identification of hearing loss reported that, although hearing-impaired children had at least factor in their medical history which put them at-risk for hearing impairment, physicians delayed referring children an average of 7.1 months after parents first expressed concern about their children's hearing (Elssmann, Matkin, &

Sabo, 1987). The problem of late or non-existent diagnosis of hearing loss is compounded for children with DD. Although data indicate that between 32% and 78% of these children also have some degree of hearing loss (Balkany, Downs, Jafek, & Krajacek, 1979; Stein, Kraus, Ozdamar, Cartee, Jabaley, Jeantet, & Reed, 1987), referral for early audiologic evaluation is not routine. Both parents and professionals may be confused by the DD and may not recognize the signs of hearing loss or may attribute their concerns about response to sound to the DD and not to impaired hearing.

One site that routinely evaluates children enrolled in programs serving children with DD is The New York League for the Hard of Hearing. In one study of children with DD who had not had hearing tests prior to those conducted at this site, 70% of the children were identified as having an educationally significant degree of hearing impairment. Personnel from The League stated that one reason for the delay in obtaining evaluations is that some professionals may not look beyond their own area of specialization in evaluating a child and, therefore, may overlook evidence of a hearing loss (Madell, 1988). This study emphasizes the need for professionals of all fields to be sensitive to any factor that may affect a child's development. While delay in diagnosis of hearing loss is tragic in all cases, it is particularly so for children with multiple disabilities because it further decreases the child's chances of reaching his or her fullest potential. Although it seems logical that hearing testing must be a routine part of the diagnostic workup when a child is being evaluated for DD, available research suggests that this is not presently the case.

The prevalence of children with hearing loss and additional disabilities also may be considered from another perspective, as was demonstrated by Gallaudet University (Gallaudet University Research Institute, 1990). This survey indicated that 30% of children with hearing

impairment had at least one additional disability. Non-physical disabilities were found to be more common than physical ones, with emotional-behavioral problems, mental retardation, and specific learning disabilities the most frequently encountered. Of the organic disabilities, cerebral palsy, visual difficulties and orthopedic were the most frequent, followed by brain damage, epilepsy, and cardiac abnormalities.

A continuing emphasis must be placed on the early and accurate identification of hearing losses in children with other disabilities, as these losses are frequently overlooked when occurring in combination with multiple physiological abnormalities. It is a medical tragedy that, even in this modern world of medicine, the silent disabilities that frequently co-exist with physical handicaps are often very delayed or even completely missed in diagnosis. This situation is compounded in later years by the reticence of many physicians to aggressively diagnose, treat/refer, and follow the child with hearing loss and additional disabilities. In part, this stems from a lack of understanding of studies which have demonstrated severe developmental delays associated with even mild hearing losses (Balkany et al., 1979; Holm & Kunze, 1969).

The developmental and psychosocial impact of hearing loss can be devastating, particularly if hearing loss is accompanied by other developmental disabilities or if the diagnosis of hearing impairment is delayed. Unfortunately, the diagnosis of childhood deafness by physicians is often inordinately delayed (Bergstrom, Hemenway, & Downs, 1971; Robinson, Willits, & Benson, 1965; Shah, Chandler, & Dale, 1978). For example, in research reported by Shah, Chandler, & Dale (1978), although the mean age of suspicion of hearing loss was 16 months of age, the average additional delay until audiological assessment was completed was 11.5 months, with a range between 0 and 60 months. Coplan (1987) reported delays in diagnosis of hearing

impairment ranging from 24 to 48 months; half of these children had associated physical anomalies that should have been clues to the potential presence of hearing loss or other disability.

Developmental and Educational Ramifications of Hearing Impairment with Additional Disability

Any condition that limits an infant's or a child's ability to acquire information from the environment, or that increases the child's dependency on others, is a disabling condition. For example, a child with limited motor ability will not experience the types and degrees of interactions with objects and with space that give the normally-developing child information about the environment. When this informational deficit is combined with the diminished amount of information the child receives as a result of impaired hearing, the effects are more than simply additive. This is true of any combination of handicaps. When two of the child's sensory modalities are impaired, not only is the sensory input reduced, but methods that are generally used to minimize the effect of one handicap may not be effective because of the second disability.

While a failure to detect a hearing loss is bad enough, far worse are the misdiagnoses experienced by one-third of the parents of hearing-impaired children (Grinker, 1969; Sullivan & Vernon, 1969). Misdiagnosis grows out of the complex problem of making a differentiation between retardation, brain damage, aphasia, delayed speech, autism, childhood schizophrenia, and hearing impairment. The grossest of these errors usually occur in children with hearing loss who have cerebral palsy, have vestibular pathology, or are in some other way multiply disabled. While this type of complication may make the errors more understandable, it also makes them more destructive because they compound the difficulties of a child already multiply disabled.

A major point to make from the issue of misdiagnosis is that delayed speech or apparent failure to respond to sound should never be ignored, nor should it be "diagnosed" as autism,

retardation, or anything else until hearing has been thoroughly tested audiologically (Vernon & Andrews, 1990). Quite often, special education placement and programming resulting from such inappropriate assessment of the child's problem have resulted in excluding these children from all but the most restrictive placements, a practice that is clearly antagonistic to the purposes of Public Law 94-142 (Flathouse, 1979). If the additional problems are of such a nature as to resist definition, measurement or remediation, the presence of a hearing loss serves to make the situation even more complicated. Even when the additional impairments are less severe, their interactions with the hearing loss and with its secondary consequences serve to multiply the effects of both (Boothroyd, 1983).

In describing services for deaf-blind children, McInnes and Treffry (1982) in their text entitled Deaf-Blind Infants and Children: A Developmental Guide describe such children as "multi-sensory impaired." Such a description that would fit any child receiving limited input from more than one sensory channel. Many of the problems McInnes and Treffry describe as resulting from the dual disability of impaired hearing and impaired vision would apply to other combinations of disabilities. These children may:

- "lack the ability to communicate with their environment in a meaningful way,
- have a distorted perception of their world,
- lack the ability to anticipate future events or the results of their actions,
- be deprived of many of the most basic extrinsic motivations,
- have medical problems which lead to serious developmental lags,
- be mislabeled as mentally retarded or emotionally disturbed,
- be forced to develop unique learning styles to compensate for their

multiple handicaps,

□ have extreme difficulty in establishing and maintaining interpersonal relationships" (McInnes & Treffry, 1982, p. 2).

Another area in which undiagnosed hearing impairments may have a particularly devastating effect for children with disabilities is the development of appropriate social competence. Social competence has been described by Mercer as "the child's ability to interact amicably with others and to cope with increasing social demands...comparable to others of his age and sex" (cited in Klansek-Kyllo & Rose, 1985, p. 533). A number of researchers have argued recently for the need to help children with disabilities acquire better social competence (Bailey & Simmeonsson, 1985; Guralnick & Groom, 1985; Hops, 1983; Strain, 1985). For most children with moderate to severe handicaps, this is very difficult. However, for the child with a disability and with an undiagnosed hearing loss, it is almost impossible. Clearly, communication is important in the socialization process. However, both the quality and quantity of communication are necessarily altered when a child has a hearing impairment. Many researchers have discussed the effects of hearing impairment on the socialization process (Meadow, 1980; Schloss, Smith, & Schloss, 1984). There are many who believe that the most debilitating effect of auditory loss is the way in which it interferes with social interaction, and particularly the degree to which this may have negative effects on the interaction between the hearing-impaired child and significant others in his or her environment (Schloss et al., 1984).

Hearing Screening and the Child with Developmental Disabilities

Testing the child with a disability for hearing loss is not easily accomplished, even under the most optimal conditions. Developmental delay and sensorimotor deficits usually alter a child's

behavior, consequently, more often than not, hearing impairment remains an invisible handicap, undocumented and undiagnosed (Rubin, Kunreuther, & Lombardi, 1983).

The child who has a developmental disability may sometimes be screened by using a conventional hearing screening protocol, such as pure tone audiometry, which requires an overt behavioral response. Often, however, a child who has multiple disabilities is unable to respond consistently to the routine test, particularly when the audiologist is limited by instrumentation in an educational setting. These children must be referred for different types of behavioral testing to determine their auditory status, such as Visual Reinforcement Audiometry (VRA), Conditioned Play Audiometry (CPA), or Tangible Reinforcement Operant Conditioning Audiometry (TROCA), or they even may be referred for objective tests, such as the Auditory Brainstem Response (ABR) or Electrocochleography (ECoG), both of which are often five to seven times more expensive than behavioral tests.

Behavioral tests are typically preferred as they provide the audiologist with information about auditory processing that is not available through objective test measurements. If a child is capable of providing an overt behavioral response to an acoustic stimulus, the child has demonstrated the ability to detect sound, process the sound at the cortical level, and respond to that sound. Results from objective test procedures, which providing certain information about how the auditory system functions, do not provide any indication of whether or not a child can process and respond to sound.

Many children with DD are not capable of providing the expected behavioral responses to conventional pure tone screening procedures. Therefore, the auditory status of these children must often be assessed through other procedures, such as with the objective test procedures

mentioned above, ABR and ECoG. While these objective measures do not require the child to participate actively in the test procedure (provide overt behavioral responses), each test does require that the child provide a prolonged state of quiet, which must often be obtained through sedation. For ABR, the test equipment is expensive and accurate results commonly cannot be obtained from children with neurological impairments. ECoG is routinely done only under sedation as the process is invasive, requiring an electrode needle to be placed on or near either the round window in the middle ear after passing through the tympanogram, or may sometimes be accomplished by placing the electrode needle on the eardrum.

However, transient evoked otoacoustic emissions (TEOAE) screening (that requires little cooperation for the child and can provide complete results for both ears in about five minutes) in combination with behavioral responses to pure tone stimuli and acoustic immittance procedures, offers a promising tool for quick, accurate screening of auditory impairment in difficult-to-test children, especially those with DD. Ecumenical use of such procedures can lead to more appropriate and effective educational management and programming.

Implementation of Otoacoustic Emissions Technology

Transient evoked otoacoustic emissions (TEOAE) greatly enhanced the field of auditory research and have proved to be immensely fascinating since they were first recorded in 1978 by Dr. David Kemp of Great Britain. Many investigators recognize that evoked otoacoustic emissions (EOAEs) are a valuable non-invasive, objective, clinical tool, as well as a tool for evaluating cochlear status in infants and young children (Bonfils, Uziel, & Pujol, 1988a, b; Elberling, Parbo, Johnsen, & Bagi, 1985; Johnsen, Bagi, & Elberling, 1983; Kemp, 1978, 1988); Kemp, Bray, Alexander, & Brown, 1986; Lutman, Mason, Sheppard, & Gibbin, 1989). These

and other investigators have shown that evoked otoacoustic emissions (EOAEs) are a property of the healthy, normal-functioning cochlea. EOAEs are generated by the electromotile response of the outer hair cells within the organ of Corti within the cochlea. Their active, frequency-selective, nonlinear characteristics are dependent on the stimulus used to generate the response, and thus allow them to be easily quantified. The electromotile response of the outer hair cells improve the ear's sensitivity to sound and enhance the fine tuning ability, particularly to low-level auditory stimuli.

Transient evoked emissions (TEOAEs) are the one class of evoked otoacoustic emission that is straightforward to measure. This ease of applicability led to the development of the only FDA-approved, commercially-available device that is available in the United States today. The Otodynamic Analyzer (ILO88) utilizes the TEOAEs to measure the status of the peripheral auditory system. To date, TEOAEs have been widely used in screening for impaired hearing primarily in infants and young children. It is possible to complete a TEOAE hearing screening in about one minute. At this time, there is no other clinical test that allows for a non-invasive, objective, sensitive, frequency selective measure of cochlear biomechanics with the operational speed and noise immunity of otacoustic emission testing (Kemp, Ryan, & Bray, 1990).

Audiometric Contribution of TEOAEs

TEOAEs may be used in many ways to contribute to the audiometric information obtained for any given individual, including as a tool for screening for hearing loss, for monitoring of cochlear status (such as for patients receiving ototoxic medications or for monitoring effects of noise exposure), and for performing differential diagnoses. TEOAEs do not, however, provide audiologists with a means of quantifying hearing loss. TEOAE results do not translate into audiometric thresholds. They do not replace audiometric data and are the only routine clinical tool unique to cochlear biomechanics. Therefore, TEOAEs cannot be used to determine the severity of hearing loss, just that there is a hearing loss. In general, only normal and near-normal ears produce any type of otoacoustic emissions. TEOAEs are sensitive to any type of peripheral hearing loss, including those that result in conductive pathology (outer and middle ear) and sensory loss (cochlear). Because they are a peripheral measure, TEOAEs are immune to more central pathology or pathologies of the neural pathways. Therefore, TEOAEs are not contaminated by central nervous system pathology, such as in cerebral palsy, and are an extremely valuable tool for ruling out peripheral auditory pathology in children with multiple disabilities, developmental delays, or central nervous system pathologies.

Otoacoustic Emissions in Combination with Other Audiometric Measures

Otoacoustic emissions technology when combined, if possible, with pure tone screening and acoustic immittance information can provide a wealth of information regarding the auditory status of children with DD. Pure tone screening reveals sensorineural hearing loss, affecting the cochlea or eighth cranial nerve. This type of screening test, however, is less effective as an indicator of conductive hearing loss, so common in young children. A conductive hearing loss is

usually a fluctuating loss, due to sound transmission obstruction between the outer ear and the hearing nerve. Middle ear effusion, or otitis media, is the leading cause of children's conductive hearing loss (Northern & Downs, 1984). The American Speech, Language, and Hearing Association (ASHA) agrees that administration of the pure tone screening test (presentation of sound frequencies ranging from 500 Hz to 4,000 Hz) as a school's only hearing screening program is insufficient. ASHA recommends that the pure tone test be combined with an auditory or acoustic impedance test (Lenich, Bernstein, & Nevitt, 1987).

Summary

The major points to be made in this section may be summarized as follows:

□ Research suggests that 78% of children with developmental disabilities (DD) have an educationally-significant hearing loss.

□ Many children with DD and accompanying hearing loss are misdiagnosed or are not identified at an early age because of the time involved in making appropriate referrals, because delays in speech and language development are attributed to developmental delay rather than to hearing loss, and because they are often difficult or impossible to evaluate using traditional audiometric procedures.

□ The value of educational and/or habilitative programs for children with one or more DD and a concomitant hearing loss may be severely impaired unless the hearing impairment is correctly diagnosed and appropriately treated.

□ TEOAE is a promising procedure to screen for hearing loss in children with DD, because the procedure is quick, non-invasive, and capable of testing both responsive and non-responsive youths due to its objective nature.

□ Although the accuracy of EOAE procedures for detecting hearing loss have been established with other populations, no data existed on the feasibility or efficacy of using TEOAE as a means of identifying hearing loss among children with DD in an educational setting.

PURPOSE

As reviewed by Patrick (1988), the goals of screening audiometry in the schools are threefold: (a) to identify children who have sufficient hearing loss that may compromise communication and/or learning in the classroom; (b) to find and send for medical management those students who have suspected middle ear pathologies; and (c) to perform the above two tasks in the most cost-efficient manner. The purpose of this project is to evaluate the feasibility of using TEOAEs to screen for hearing loss in 3 to 7 year old children with developmental disabilities (DD), and to compare the effectiveness of using TEOAE screenings versus conventional hearing screenings typically incorporated in educational settings. The specific goals of this project are to:

- (1) establish the auditory status of a group of children previously identified as having DD and a group of children with no documented DD using an audiometric test battery;
- (2) compare the sensitivity and specificity of two conventional screening programs recognized by the American Speech-Language-Hearing Association with TEOAE screening programs in a group of children with DD and a group of children without DD;
- (3) compare results of children with DD to TEOAE results from children without DD; and

- (4) compare the cost effectiveness of TEOAE and conventional audiometric screening techniques in a group of children with DD and a group of children without DD.

Project Objectives for Year One

The primary goals for the first year of the project focused on coordination of data collection, obtaining human subjects approval to initiate data collection, and to schedule schools within each of the participating districts. Contact persons, phone numbers, and addresses of the schools within the districts were identified and compiled. Test protocols, data sheets, and database encoding sheets were developed. Data collection was initiated first with a group of children without disabilities, and then proceeded to children with one or more DD. The specific objectives for Year One were to:

1) Assess current practices in the field;

2) Obtain research approval for use of human subjects from USU;

3) Obtain research approval for participation of students from school districts;

4) Develop data collection protocols;

5) Develop data sheets and data encoding sheets;

6) Train data collection audiologists;

7) Collect data from 250 children with no identified DD;

8) Evaluate and modify data collection protocols, data sheets, and data encoding sheets as needed;

9) Coordinate, schedule, and complete consultation visit with Dr. Martin Robinette regarding test protocols, data collection, and data analysis;

10) Develop database program for data input;

11) Collect data from 100 children with DD;

12) Provide ongoing coordination with school districts, schools, district audiologists, and other involved personnel;

13) Provide ongoing coordination with USU Speech-Language-Hearing Center for children needing follow-up services as needed;

14) Provide technical support to district audiologists in identification, quantification, and management of hearing loss in children with and without DD;

15) Provide follow-up services and consultation to school districts, schools, or educators regarding children with and without DD identified as having a hearing loss; and

16) Input data collected from children with and without DD into the computer database program

Project Objectives for Year Two

Most of the activities during the second year centered on data collection from children with one or more DD. Fundamental information necessary for determining the cost effectiveness of the various screening methods employed were also recorded. The objectives for year two of the project were to:

1) Coordinate clinical services with the USU Speech-Language-Hearing Center;

2) Coordinate scheduling and data collection with school districts and district audiologists;

3) Obtain local school districts' research protocol approval;

4) Collect data from 350 children with DD;

5) Provide technical support to local and district audiologists, special education coordinators, and other involved personnel regarding the identification, assessment, and management of children with DD who also have a hearing loss;

6) Input data collected into the computer database;

7) Analyze data collected from children without DD; and

8) Begin data dissemination from results of children without DD.

Project Objectives for Year Three

The project objectives for year three are focused on completion of data collection, data analysis, and preparation for dissemination of data. The specific objective of the third and final year of the project are to:

1) Coordinate ongoing clinical services with USU Speech-Language-Hearing Center;

2) Provide technical support to district audiologists, educators, and other personnel as needed regarding the identification, assessment, and management of children with one or more DD and hearing loss;

3) Collect data on an additional 200 children with DD;

4) Analyze data from 750 children with DD; and

5) Prepare for dissemination of all data collected.

PROJECT ACCOMPLISHMENTS

Review of Current Practices

Prior to developing the data collection protocol, current practices for audiometric services offered in educational settings were reviewed. Extreme variability exists in screening protocols, personnel performing screenings, and children targeted for hearing screenings in schools throughout the educational system. Whenever possible, therefore, the research protocols for this study were based on guidelines developed by the governing bodies of the field, the American Academy of Audiology and the American Speech-Language-Hearing Association. Further information regarding the specific protocols used for this study are described in the Methodology section of this report.

Human Subjects Approvals

Prior to initiating the study, it was necessary to obtain human subjects approval from the Utah Office of Special Education, from Utah State University, and from each of the participating school districts. Eleven school districts in Northern Utah participated in the project: Logan City School District, Cache Valley School District, Ogden School District, Weber School District, Box Elder School District, Provo City School District, Jordan School District, Davis School District, Alpine School District, Granite School District, and the Utah Schools for the Deaf and the Blind. The majority of the school districts were extremely anxious to participate in the study because (a) they were aware and were concerned that a substantial number of children with DD may have undetected and, consequently, unhabilitated hearing losses that interfere with appropriate educational programming for the affected children, (b) they acknowledged that traditional methods of hearing screening often have serious limitations in their ability to detect hearing loss in

children with specific disabilities, and © they believed that the initial stage of identification of hearing loss is at once the most important and most difficult step in the process of audiologic and habilitative follow-up.

In light of these difficulties and concerns, they recognized the need for and the value of a reliable, quick and non-invasive hearing screening test for children with other disabilities, and they believed that the EOAE procedure had the potential to be a valuable tool in identifying hearing loss in difficult-to-test children, such as those with DD, getting them "on the track" for audiologic habilitation and subsequent essential and appropriate educational programming. The applications for project approval and the letters received from the school districts and from Utah State University are found in Appendix A. When possible, data collection was coordinated to coincide with routine hearing screenings being conducted in the school districts. Schedules used for data collection are found in Appendix B.

Prior to Data Collection

Prior to the initiation of the project, letters of support were obtained from Dr. Steven Kukic, Director of Special Education for the State of Utah, and from Utah school districts who planned to participated in the project (see Appendix A). When the notification of funding was received, the Utah State Board of Education was informed and clearance was obtained to proceed with making contacts with the contact persons for each school district. Meetings were arranged to complete the following objectives:

• To present and discuss the importance and goals of the research and answer questions related to the implementation of the project in the particular school district;

• To discuss the necessity of and/or procedures for informed consent for conducting hearing screening of students. It should be noted that the State of Utah has a legislative recommendation which states that hearing screenings should be conducted by local school districts for "grades 1, 2, and 3, high-risk students, and students new to the schools," even though most school districts do not do hearing screenings.

• To obtain the names of eligible students and their parents/guardians, the names of the students' respective schools, and the names of the respective schools' principals for scheduling the hearing evaluations;

• To delineate the referral process for children identified by the project as having a possible hearing loss. This included such items as identifying appropriate personnel for audiologic and/or medical follow-up as needed, outlining financial obligations (if any), and for provision of any other follow-up services deemed necessary.

Principals at the each of the participating schools within each school district were contacted and informed of the project objectives, the benefits to the children with DD and their families and educators who elected to participate, and the general protocols employed during data collection. In several schools or school districts, a local project coordinator was appointed to facilitate interactions between the school and the researchers. Local project coordinators included special education coordinators, audiologists, speech-language pathologists, and in some cases classroom teachers working with children with disabilities. Lists of potential subjects and their parents were obtained, and tentative outlines for data collection were scheduled.

For the onset of data collection, data sheets and data encoding sheets were designed, evaluated, and revised to ensure that the overall process was efficient. The audiologists involved

in data collection (two were used for each session) were briefed on the overall process, the design of the study, their responsibilities to the project, and the importance of ensuring that they kept the screening results of their portion of the data collection confidential until all data were collected for each child. The audiologists also were trained on the procedures and protocols to be followed during the data collection, the importance of establishing the correct auditory status for each ear for each participant, and the necessity of ensuring that children identified as having a hearing loss were referred appropriately to ensure that they received any additional services or modifications to their ongoing educational program. The data collection, scheduling, and encoding sheets developed for this project are available in Appendix C.

One additional measure to ensure that the project design, protocols, and data collection procedures were in line with current best practices was to conduct an on-site visit by a national expert in audiology, Dr. Martin Robinette from the Mayo Clinic in Rochester, Minnesota. The report of his consultation is presented in Appendix D.

Data Collection

The initial phases of the project were initiated with children with no identified developmental disabilities. Data collection was coordinated with the ongoing school screening programs in the Logan City School District and the Cache Valley School District. Parental permission was therefore not required for the 250 participants. At the completion of data collection for the group of children with no identified DD, the second group of children, those with one or more DD, were scheduled for participation. Data collection encompassed the majority of the activities conducted throughout the first two years of the project.

Data Analysis and Dissemination

Data were encoded into an SPSS computer file designed specifically for this project on a routine basis throughout the project. At the completion of data collection from the group of children without DD, group data were analyzed. Dissemination of the results from this group of children commenced during the second year of the project. Analysis of the data obtained from the group of children with DD were conducted during the third and final year of the project. Although dissemination of data is still underway, a list of completed dissemination activities which have taken place to date on a national basis has been compiled, and examples of some of the materials used during these activities are available in Appendix E.

METHODOLOGY

Procedures

In the study, children both with and without DD, had two types of hearing screenings: (1) a conventional pure tone audiometry screening with and without tympanometry and (2) a TEOAE screening. In addition, each participant completed a battery of tests designed to establish the auditory status of each child. The test battery included both objective and behavioral measures of hearing. Determining the auditory status of each ear of each child was crucial for data analysis, for the auditory status was used as the golden standard upon which the hearing screenings were evaluated. The behavioral tests in the battery used to determine auditory status included: case history information, otoscopy, and pure tone testing. The objective measures in the test battery included: immittance audiometry and TEOAEs. For the overwhelming majority of the participants, the battery of tests and the hearing screenings could be completed in the school

setting. For some children, it was necessary to schedule an audiometric assessment in an audiology suite, typically outside the school setting. The audiological services necessary to determine auditory status were conducted free of charge.

RESULTS

Subjects

Two groups of children were targeted for subjects in this study: (1) 250 children aged five to seven with no documented DD, and (2) 750 children aged three to seven with documented DD[1]. For the first group, 352 children participated in the study whereas 765 children served as subjects for the second group for an overall total of 1117 subjects. A total of 90 schools from eleven school districts participated in the study. Details of the participants, school districts, and individual schools of this project are available in Appendix F. For several school districts, data collection was coordinated with ongoing hearing screening programs. As such, children who participated in the mass screenings were not required to obtain parental permission. In districts where data collection was conducted independently of the ongoing school hearing screening programs, parental permission was obtained for each child to participate through mailings. In addition to the permission forms, a questionnaire (see the Utah State University Human Subjects Approval application in Appendix A) was included for parents to complete regarding the hearing history of their child.

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[1]In certain instances, children are not "assigned" a specific developmental disability in Utah prior to their enrollment in Kindergarten. Many of the three and four year olds with developmental disabilities, therefore, were identified as having special needs, but were not classified in the same manner as the older children.

Further information regarding the subjects of this study are presented in the following tables, including a breakdown of the children by age and by developmental disability. Sufficient data were collected from 1062 subjects to be entered into the database, 336 were children without disabilities and 726 were children with DD.

Table 1: Breakdown of Subjects by Age.

	Children Without Disabilities		Children with Disabilities	
Age	Number	Percent	Number	Percent
3			71	9.8%
4			134	18.5%
5	71	21%	147	20.2%
6	123	37%	177	24.4%
7	138	41%	194	26.7%
8	4	1%	3	0.1%
Total	**336**	**100%**	**726**	**100%**

Table 2: Breakdown of Subjects with Developmental Disabilities by Disability Category

		Regular Class	Resource Room	Special Classroom	Total
Intellectual Disability		14	9	43	66
Learning Disability		32	61	6	99
Behavioral Disorder		11	7	8	26
Communicative Disorder		111	69	11	191
Developmental Delay		15	87	156	258
Orthopedic Impairment		2			2
Other Impairment		2	2	1	5
Multiple Disabilities		4	3	21	28
Autism		2		1	3
Hearing Impaired		1	2		3
In Process	3				3
Unknown	42				42
Totals	**45**	**194**	**240**	**247**	**726**

Auditory Status

Determining the auditory status of each ear of each participant in this study was one of the primary objectives during data collection. Auditory status could not be determined for the either ear for 21 subjects from the group of children with developmental disabilities. Because these subjects were from 14 different classrooms, varied according to age, were equally representative of gender, and varied according to disability, they were excluded from data analysis. Although these excluded subjects were placed either in special classrooms or were receiving resource assistance at the time of the study as opposed to being in regular classrooms, it was not felt that their exclusion would affect outcomes due to the large sample size. Table 3 presents further details of the 21 excluded children according to age, and Table 4 presents information regarding the excluded children according to disability category.

Table 3: Details of Subjects Excluded from Data Analysis According to Age due to Lack of Information Delineating Auditory Status for Both Ears.

Age	Number of Children	Percent of Exclusion	Percent of Data Set
3	6	28.6	0.83
4	5	23.8	0.69
5	3	14.3	0.41
6	6	28.6	0.83
7	1	4.8	0.14
Total	**21**	**100.0**	**2.9**

It is interesting to note that of the subjects for whom the auditory status could not be determined, the parents of 18 of those subjects had indicated that they have concerns regarding their child's hearing. Also of interest was that nine of these children had a history of middle ear

pathology and eight had received at least one set of PE tubes. For each of these children, referrals were made to appropriate sources in their communities for follow-up and intervention, if necessary.

Table 4: Details of Subjects Excluded from Data Analysis According to Disability Category due to Lack of Information Delineating Auditory Status for Both Ears.

Disability	Number		Percent Excluded	Percent of Data Set
	Resource Room	Special Class		
Orthopedic Impairment	1		4.8	0.14
Communicative Disorder	2		9.6	0.28
Developmental Delay	5	3	38.1	0.96
Multiple Disabilities		5	23.8	0.69
Autism		1	4.8	0.14
Intellectual Disability		1	4.8	0.14
Unknown	3		14.3	0.41
Total	**11**	**10**	**100**	**2.9**

Although auditory status could not be established for an additional 27 left ears and 35 right ears of children with DD, complete data sets were obtained on two thirds (66%) of the children from this group (481 of 726). Determining the auditory status of the children without DD was not difficult, for both ears of all of the children tested were determined in the educational setting. Complete data sets were obtained from 312 of the 336 children (93%) without DD. These data reflect the increased difficulty of obtaining audiometric results from children with DD in an educational setting, even with trained and certified audiologists performing the tests.

To improve the accuracy of data analysis, each ear of each child was categorized independently. This was designed to reflect the differences between the portions of the auditory system measured by the different hearing screening methods and by the different components of the audiometric test battery: (1) otoscopy and tympanometry reflect the status of the outer and middle ear; (2) otoacoustic emissions reflect the status of the inner ear in addition to the outer and middle ear; and (3) pure tone thresholds and pure tone screenings reflect the status of the entire auditory system, including the central auditory pathways and central processing.

Thus, because by definition hearing includes the ability to process sound, the only measures that truly reflect "hearing" status are the pure tone screening results and the pure tone thresholds. Auditory status was therefore divided into five categories: (1) Normal Hearing, Normal Tympanograms; (2) Normal Hearing, Abnormal Tympanograms; (3) Abnormal Hearing, Abnormal Tympanograms; (4) Abnormal Hearing, Normal Tympanograms; and (5) Undetermined

Ears in the first category are referred to as normal/normal, indicating that both audiometric thresholds and tympanograms (middle ear status) were normal. Under ideal conditions, all ears in the normal/normal category will pass both pure tone hearing screenings and TEOAE screenings. For ears in the second category, although audiometric thresholds were within normal limits, abnormal tympanograms were measured. All ears in this category should pass the pure tone screening that does not include the tympanogram, but should be referred for the pure tone screening incorporating the tympanogram and possibly for the TEOAE screening. It was anticipated that, as with most conductive pathologies, there would be more variability in the measures not present with purely sensorineural or normal hearing conditions.

The third group, abnormal hearing, abnormal tympanograms, should have all ears being referred from each of the screening protocols. This group includes ears with purely conductive hearing loss or ears with mixed hearing loss. The fourth group, abnormal hearing, normal tympanograms, should include ears with purely sensorineural hearing loss. For each of these ears, each of the pure tone screenings should result in referrals and the majority of the TEOAE screenings should be referrals. It is possible, however, that some of the ears with mild or slight hearing losses may pass the TEOAE hearing screening. A pass on a TEOAE screening suggests hearing at 30 dB HL or better, whereas normal hearing is defined as hearing at 20 dB HL or better. The final group includes those ears for which audiometric status could not be determined under the test conditions available in the school setting. For most analyses (unless otherwise indicated), these ears are excluded from the data set. For the left ear, almost 3/4 of the ears had normal hearing and normal tympanograms, while 15% of the ears demonstrated abnormal hearing (see below).

Left Ear Auditory Status for Children with Developmental Disabilities		
Auditory Status Category	Number of Ears	Percent
Normal Hearing/Normal Tympanograms	535	73.69%
Normal Hearing/Abnormal Tympanograms	53	7.03%
Abnormal Hearing/Abnormal Tympanograms	66	9.09%
Abnormal Hearing/Normal Tympanograms	45	6.20%
Undetermined	27	3.72%

Similar results were obtained for the right ears of the children with one or more DD. Again, almost 3/4 of these ears had normal hearing and normal tympanograms while 16% of the

right ears demonstrated abnormal hearing. From these results, it would be anticipated that about one quarter of both the left and right ears of children with one or more disability would fail the hearing screening.

Right Ear Auditory Status for Children with Developmental Disabilities		
Auditory Status Category	Number of Ears	Percent
Normal Hearing/Normal Tympanograms	515	70.94%
Normal Hearing/Abnormal Tympanograms	58	7.99%
Abnormal Hearing/Abnormal Tympanograms	75	10.33%
Abnormal Hearing/Normal Tympanograms	43	5.92%
Undetermined	35	4.82%

When the auditory status of the group of children with no identified DD are recorded, fewer ears demonstrated abnormal results. Almost 90% of the left ears demonstrated both normal hearing and normal tympanograms (see below) while about 3% of the ears presented abnormal hearing and 9% had abnormal middle ear status.

Left Ear Auditory Status for Children with No Developmental Disabilities		
Auditory Status Category	Number of Ears	Percent
Normal Hearing/Normal Tympanograms	302	89.88%
Normal Hearing/Abnormal Tympanograms	24	7.14%
Abnormal Hearing/Abnormal Tympanograms	5	1.49%
Abnormal Hearing/Normal Tympanograms	5	1.49%
Undetermined	0	0%

Results for the right ears from the group of children with no DD mirrored the results obtained from the left ears, with 90% of the ears demonstrating normal hearing and normal tympanograms. Abnormal middle ear status was apparent in 8% of the cases, and abnormal auditory status was demonstrated by 4% of the right ears of the children with no DD.

Right Ear Auditory Status for Children with No Developmental Disabilities		
Auditory Status Category	Number of Ears	Percent
Normal Hearing/Normal Tympanograms	303	90.19%
Normal Hearing/Abnormal Tympanograms	20	5.95%
Abnormal Hearing/Abnormal Tympanograms	6	1.79%
Abnormal Hearing/Normal Tympanograms	7	2.08%
Undetermined	0	0%

Hearing Screening Protocols

Two conventional hearing screening protocols were examined: Asha-A and Asha B. The Asha-A protocol screens each ear with pure tones of 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz at 20 dB HL for each ear. The child must hear each frequency at 20 dB HL (or lower) to pass the screening. The Asha-B protocol is similar, but tympanometry is substituted for the 500 Hz pure tone signal. Thus, the Asha-A screening protocol is pure tone screening only and Asha-B is pure tone and tympanometric screening.

The third and fourth screening protocols examined by this project were TEOAE screenings. Unlike the pure tone screening, however, there are no standards for conducting hearing screenings using TEOAEs. Pass/refer criteria for the TEOAE screenings, therefore, were based on the best clinical practices available during the project. Because, the results of the

TEOAE screening are stored in the computer and are available for later review, a variety of pass/refer criteria may be evaluated from a single screening session as long as the test parameters are kept constant. For the TEOAE screenings, therefore, the test parameters (also called test validity) were as follows:

- Target stimulus of 80 dB pk, with acceptable range between 77 dB and 83 dB;
- At least 50 low noise samples averaged;
- Stimulus stability 75% or greater; and
- Stimulus spectrum present across test frequencies (1000-4000 Hz).

For this project, a single TEOAE hearing screening data collection session, that used two different criteria for differentiating pass from refer, was used to evaluate the two protocols. The two criteria used in this study were the "visual pass" criteria first described and used by the prominent Rhode Island Hearing Assessment Project (RIHAP) (1993), and the "bandwidth reproducibility" criteria adopted by the National Consortium for Newborn Hearing Screening (1995). For TEOAE responses to pass the "visual pass" criteria, the response must meet the test validity criteria outlined above and the Fast Fourier Transfer (FFT) of the response measure must be present across at least half of three frequency bandwidths, 1000 to 2000 Hz, 2000 to 3000 Hz, and 3000 to 4000 Hz. To pass the "bandwidth reproducibility" criteria, the TEOAE response also must meet the test validity criteria. In addition, the reproducibility must be 50% or better for the 1600 Hz frequency bandwidth and 70% or better for the 2400 Hz, 3200 Hz, and 4000 Hz frequency bandwidths.

Asha-A Hearing Screening

When examining the Asha-A pure tone hearing screening protocol (screening at 20 dB HL for 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz) , three possible outcomes were possible: pass, fail, and could not determine. For the group of children with no DD, all children for whom audiometric status was defined completed the protocol for each ear (see table below). For each ear, almost 80% of the children passed the screening while about 20% failed the screening.

Right Ear Asha-A Hearing Screening Protocol for Children without Disabilities		
Results	Frequency	Percent
Pass	263	78.3
Fail	73	21.7
Could Not Determine	0	0

Left Ear Asha-A Screening for Children without Developmental Disabilities		
Results	Frequency	Percent
Pass	269	80.1
Fail	67	19.9
Could Not Determine	0	0

For the group of children with DD, although the same outcomes were possible, fewer children were able to complete the hearing screening. For both right and left ears, 32% of the children with one or more DD were unable to complete the screening protocol. Although the majority (63%) of the children who did not complete the screening were aged 3 to 4 years, 37% of the children aged 5 to 7 years did not complete the screening. Results could not be obtained for one ear for only seven children, while pure tone screening could not be completed for both

ears of 234 of the children in the group. Of the subgroup of children for whom the pure tone screening could not be completed, the auditory status could be established through other means. The presence of an educationally significant hearing loss was ruled out for all but 17 children.

Right Ear Asha-A Screening for Children with Developmental Disabilities		
Results	Frequency	Percent
Pass	243	33.5
Fail	245	33.8
Could Not Determine	237	32.7

Left Ear Asha-A Screening for Children with Developmental Disabilities		
Results	Frequency	Percent
Pass	269	37.1
Fail	221	30.5
Could Not Determine	235	32.4

Asha-B Hearing Screening Protocol.

When the Asha-B pure tone/immittance screening results of the group with no DD were examined, again almost all children completed the protocol. Results were obtained for over 99% of both right and left ears, and over 85% of the obtained results were passes. Tympanograms could not be obtained from one ear of four different children (three 6 year olds, one 7 year old), 2 right ears and 2 left ears.

Right Ear Asha-B Screening for Children without Disabilities		
Results	Frequency	Percent
Pass	292	86.9
Fail	42	12.5
Could Not Determine	2	0.6

Left Ear Asha-B Screening for Children without Developmental Disabilities		
Results	Frequency	Percent
Pass	286	85.1
Fail	48	14.3
Could Not Determine	2	0.6

For the group of children with DD, again the protocol could not be completed by one third of the subjects for each ear. As might be expected from the results of the Asha-A protocol with children with DD, many of the subject could not complete the pure tone screening portion of the Asha-B protocol for either ear. However, tympanograms were obtained from 94 to 95% of these subjects. The objective portion of the Asha-B protocol was completed for many more subjects than the behavioral portion.

Right Ear Results for the Asha-B Screening Protocol with Children with Developmental Disabilities		
Results	Frequency	Percent
Pass	243	33.5
Fail	245	33.8
Could Not Determine	237	32.7

Left Ear Asha-B Screening for Children with Developmental Disabilities		
Results	Frequency	Percent
Pass	360	49.7
Fail	124	17.1
Could Not Determine	241	33.2

Visual Pass TEOAE Hearing Screening Protocol.

Using the Visual Pass TEOAE hearing screening protocol, only two ears could not be tested from the children with no DD. Both right and left ear pass rates were 83%, and refer rates were 13%. Three percent of the completed tests that were completed for each ear did not meet the test validity criteria, and were therefore not included in further data analyses. The invalid tests were generally due to tester error as opposed to being a factor of the subjects being screened, such as failing to average an appropriate number of low noise samples or altering the probe fit after stimulus calibration to the extent that the stimulus was no longer in the acceptable range.

Right Ear Visual Pass TEOAE Protocol for Children without Disabilities		
Result	Frequency	Percent
Pass	279	83.0
Refer	45	13.4
Invalid	11	3.3
Could Not Test	1	0.3

Left Ear Visual Pass TEOAE Protocol for Children without Disabilities		
Result	Frequency	Percent
Pass	280	83.3
Refer	46	13.7
Invalid	9	2.7
Could Not Test	1	0.3

For the children with DD, only eleven children could not be tested (2%). Although these children varied according to their age (four 3 year olds, two 4 year olds, three 5 year olds, and two 6 year olds), all but one of the children were in special classrooms, and all but three were tactually defensive. For 5 of the 11 children, tympanograms were also not obtained.

Right Ear Visual Pass TEOAE Protocol for Children with Developmental Disabilities		
Result	Frequency	Percent
Pass	537	74.1
Refer	165	22.8
Invalid	12	1.7
Could Not Test	11	1.5

Left Ear Visual Pass TEOAE Protocol for Children with Developmental Disabilities		
Result	Frequency	Percent
Pass	522	74.1
Refer	179	22.8
Invalid	12	1.7
Could Not Test	12	1.7

Consortium TEOAE Hearing Screening Protocol.

When the TEOAE pass/refer criteria developed by the National Consortium for Newborn Hearing Screening are used as a hearing screening protocol, fewer ears pass for children in both groups of this study. For children without DD, right ear results passed 69% of the time while left ears passed 65% of the time. Refer rates were 29% and 32%, with about 3% of the results from each ear not being analyzed because they did not meet the test validity criteria.

Right Ear TEOAE Consortium Protocol for Children without Disabilities		
Result	Frequency	Percent
Pass	228	68.9
Refer	96	28.6
Invalid	11	3.3
Could Not Test	1	0.3

Left Ear TEOAE Consortium Protocol for Children without Disabilities		
Result	Frequency	Percent
Pass	217	64.6
Refer	109	32.4
Invalid	9	2.7
Could Not Test	1	0.3

For children with DD, over half of the ears were referred by the consortium TEOAE protocol. For the right ear, 57% were referred while 56% of the left ears were referred while 38% and 41% of the right and left ears passed, respectively. Because the results of a single screening session were used to evaluate both the visual pass and the Consortium TEOAE hearing

screening protocols, the same percentage of ears that could not be tested or that had invalid screening results were measured for both. When the results of the two TEOAE screening protocols are compared, it is apparent that the Consortium protocol, that is based primarily on neonatal hearing screening criteria, is the more conservative of the two protocols.

Right Ear TEOAE Consortium Protocol for Children with Developmental Disabilities		
Result	Frequency	Percent
Pass	277	38.2
Refer	425	58.6
Invalid	12	1.7
Could Not Determine	11	1.5

Left Ear TEOAE Consortium Protocol for Children with Developmental Disabilities		
Result	Frequency	Percent
Pass	298	41.1
Refer	403	55.6
Invalid	12	1.7
Could Not Determine	12	1.7

Objective Two: Determining Sensitivity and Specificity of Screening Protocols

The second objective of this project was to determine the sensitivity and specificity of the conventional hearing screening protocols and the TEOAE screening protocols used in this study. Two of the most well-recognized method of evaluating the effectiveness of a test protocol is to examine the sensitivity and specificity of that protocol. Sensitivity, or the true positive rate, refers to the protocol's ability to detect the presence of a pathology when the pathology exists.

Specificity, or the true negative rate, refers to the protocol's ability to distinguish correctly the absence of a pathology. For a perfect test or protocol, both sensitivity and the various specificity are equal to 1.0. Several other test operant characteristics which are of interest for evaluating screening protocols used in this project are the false negative rate, false positive rate, the over referral rate, the under referral rate, positive and negative predictive values, and overall agreement. The figure on the following page provides further detail about these terms and how they are calculated.

Auditory Status

Screening Protocol	Abnormal Hearing	Normal Hearing
Refer	A	B
Pass	C	D

N

A=True Positive	C=False Negative
B=False Positive	D=True Negative
Overall Agreement	= A+D/N*100
Sensitivity	= A/A+C*100
Specificity	= D/B+D*100
Positive Predictive Value	= A/A+B*100
Negative Predictive Value	= D/C+D*100
False Negative	= 100 - Sensitivity
False Positive	= 100 - Specificity
Over referral	= 100 - Positive Predictive Value
Under referral	= 100 - Negative Predictive Value

Sensitivity and Specificity of the Asha-A Pure Tone Screening Protocol

The information below presents the results of the Asha-A pure tone screening results, screenings using 500, 1000, 2000, and 4000 Hz at 20 dB HL, for children with no identified DD. With a sensitivity value of only 50%, this protocol failed to identify half of the children with abnormal ears while almost 85% of the children with normal hearing passed the screening. Thus, under typical screening situations, 15% of the children with normal hearing would have been referred for additional services, whether screening, diagnostic assessment, or other services. Of these children, 93% (314) completed the hearing screening for the right ear.

Operant Characteristics for the Asha-A Hearing Screening Protocol for the Right Ears of the Group of Children without Disabilities

A	12	Sensitivity	50.00
B	45	Specificity	84.48
C	12	Positive Predictive Value	21.05
D	245	Negative Predictive Value	95.33
		False Negative	50.00
N	314	False Positive	15.52
		Over referral	78.95
		Under referral	4.67
		Overall Agreement	81.85

When the operant characteristics of the Asha-A pure tone hearing screening protocol were examined for the left ears of the group of children with no identified DD (see below), results were similar to those measured for the right ear. Screening was completed for 97% of the left ears (325 of 336). The overall agreement for both right and left ears was about 82%.

Operant Characteristics for the Asha-A Hearing Screening Protocol for the Left Ears of the Group of Children without Disabilities

A	15	Sensitivity	48.39
B	44	Specificity	85.03
C	16	Positive Predictive Value	25.42
D	250	Negative Predictive Value	93.98
		False Negative	51.61
N	325	False Positive	14.97
		Over referral	74.58
		Under referral	6.02
		Overall Agreement	81.54

When the group of children with DD was screened, fewer subjects were able to complete the task. For this group, 488 of the 691 children for whom the auditory status was determined (71%) completed for the right ear and 490 of the 699 (70%) for the left ear. When the Asha-A hearing screening protocol operant characteristics were examined with the group of children with one or more DD, sensitivity was 84% for right ear results and 71% for left ear results. Specificity for the right ear was 58% and 61% for the left ear. The overall agreement for both right and left ears was almost 63%. Further detail regarding the data are available below.

Operant Characteristics for the Asha-A Hearing Screening Protocol for the Right Ears of the Group of Children with one or more Developmental Disabilities

A	79	Sensitivity	84.04
B	166	Specificity	57.87
C	15	Positive Predictive Value	32.24
D	228	Negative Predictive Value	93.83
		False Negative	15.96
N	488	False Positive	42.13
		Over referral	67.76
		Under referral	6.17
		Overall Agreement	62.91

Operant Characteristics for the Asha-A Hearing Screening Protocol for the Left Ears of the Group of Children with one or more Developmental Disabilities

A	63	Sensitivity	70.79
B	158	Specificity	60.60
C	26	Positive Predictive Value	28.51
D	243	Negative Predictive Value	90.33
		False Negative	29.21
N	490	False Positive	39.40
		Over referral	71.49
		Under referral	9.67
		Overall Agreement	62.45

Sensitivity and Specificity of the Asha-B Pure Tone Screening Protocol

The Asha-B pure tone/tympanometry screening was the second hearing screening protocol examined. When data for the group of children with no DD are examined (see below), the numbers are impressive. From this group, screening results were obtained for 93% of the right ears and for 96% of the left ears. For both ears, sensitivity was 100% and specificity was 98% and 96% for the right and left ears, respectively.

Operant Characteristics for the Asha-B Hearing Screening Protocol for the Right Ears of the Group of Children with No Developmental Disabilities

A	24	Sensitivity	100.00
B	6	Specificity	97.92
C	0	Positive Predictive Value	80.00
D	282	Negative Predictive Value	100.00
		False Negative	0.00
N	312	False Positive	2.08
		Over referral	20.00
		Under referral	0.00
		Overall Agreement	98.08

Operant Characteristics for the Asha-B Hearing Screening Protocol for the Left Ears of the Group of Children with No Developmental Disabilities

A	31	Sensitivity	100.00
B	12	Specificity	95.89
C	0	Positive Predictive Value	72.09
D	280	Negative Predictive Value	100.00
		False Negative	0.00
N	323	False Positive	4.11
		Over referral	27.91
		Under referral	0.00
		Overall Agreement	96.28

High numbers were also realized for the Asha-B hearing screening protocol for the group of children with one or more identified DD, although the percent of subjects who were able to be screened from this group of children was below that of the group of children without DD. Only 70% of the subjects were able to complete the screening protocol for the right ear and 69% for the left ear.

Operant Characteristics for the Asha-B Hearing Screening Protocol for the Right Ears of the Group of Children with One or more Developmental Disabilities

A	88	Sensitivity	95.65
B	34	Specificity	91.26
C	4	Positive Predictive Value	72.13
D	355	Negative Predictive Value	98.89
		False Negative	4.35
N	481	False Positive	8.74
		Over referral	27.87
		Under referral	1.11
		Overall Agreement	92.10

Operant Characteristics for the Asha-B Hearing Screening Protocol for the Left Ears of the Group of Children with One or more Developmental Disabilities

A	86	Sensitivity	98.85
B	38	Specificity	90.43
C	1	Positive Predictive Value	69.35
D	359	Negative Predictive Value	99.72
		False Negative	1.15
N	484	False Positive	9.57
		Over referral	30.65
		Under referral	0.28
		Overall Agreement	91.94

Sensitivity and Specificity of Visual Pass TEOAE Hearing Screening Protocol

When examining the sensitivity and specificity of the TEOAE screenings, it was anticipated that the sensitivity measure could be negatively influenced in two ways: (a) children who were classified as having abnormal auditory status due to negative middle ear pressure could potentially pass the TEOAE screenings, and (b) normal hearing is reflected by pure tone thresholds of 20 dB HL or better while TEOAEs are most sensitive to hearing loss of 30 dB HL or greater. Therefore, the two TEOAE screening protocols examined are presented in two different ways. The first presentation for each ear of each group was conducted using the auditory status discussed in the methodology section as the golden standard. In addition, TEOAEs were evaluated with a slight variation only on the tympanogram portion of determining auditory status.

Because it is possible to measure otoacoustic emission in the presence of negative pressure, ears that had normal hearing but abnormal tympanograms (except for Type B or flat tympanograms unless PE tubes were present) were included in the normal hearing category. By doing so, ears with normal hearing that passed TEOAE screenings were not penalized for the

presence of negative pressure. However, because by definition normal hearing is 20 dB HL or less, ears presenting a slight to mild hearing loss that passed the TEOAE are still included in the false negative category if the TEOAE hearing screening was passed.

The first TEOAE screenings were evaluated using Visual Pass protocol. For this protocol, hearing screenings were completed for 96% of both right and left ears from the group of children without DD. When the operant characteristics of the visual pass protocol were evaluated using the same criteria as the pure tone screening protocols, the sensitivity was 47% for the right ear and 67% for the left ear for children without disabilities. Specificity values were 90% and 82% for the right and left ears, respectively. Overall agreement was 85% and 89%. Thus, similar to the Asha-A protocol, nearly half of the ears classified as abnormal were passed using the visual pass protocol.

Operant Characteristics for the Visual Pass TEOAE Protocol for the Right Ear of Children without Disabilities

A	15	Sensitivity	46.88
B	30	Specificity	89.73
C	17	Positive Predictive Value	33.33
D	262	Negative Predictive Value	93.91
		False Negative	53.13
N	324	False Positive	10.27
		Over referral	66.67
		Under referral	6.09
		Overall Agreement	85.49

Operant Characteristics for the Visual Pass TEOAE Protocol for the Left Ear of Children without Disabilities

A	22	Sensitivity	66.67
B	24	Specificity	91.81
C	11	Positive Predictive Value	47.83
D	269	Negative Predictive Value	96.07
		False Negative	33.33
N	324	False Positive	8.19
		Over referral	52.17
		Under referral	3.93
		Overall Agreement	89.26

However, if the presence of negative middle ear pressure is allowed for (see description above), the sensitivity of the visual pass TEOAE hearing screening is improved dramatically. When these data are reanalyzed, sensitivity for the right ear improves to 88% and the left ear improves to 100%. Specificity measures are not dramatically altered, but overall agreement increases.

Operant Characteristics for the Visual Pass TEOAE Protocol for the Right Ear of Children without Disabilities when allowing for Negative Middle Ear Pressure

A	15	Sensitivity	88.24
B	30	Specificity	90.20
C	2	Positive Predictive Value	33.33
D	276	Negative Predictive Value	99.28
		False Negative	11.76
N	324	False Positive	9.80
		Over referral	66.67
		Under referral	0.72
		Overall Agreement	90.09

Operant Characteristics for the Visual Pass TEOAE Protocol for the Left Ear of Children without Disabilities when allowing for Negative Middle Ear Pressure

A	22	Sensitivity	100.00
B	24	Specificity	92.11
C	0	Positive Predictive Value	47.83
D	280	Negative Predictive Value	100.00
		False Negative	0.00
N	324	False Positive	7.89
		Over referral	52.17
		Under referral	0.00
		Overall Agreement	92.64

When the same measures are completed for the group of children with DD, similar operant characteristics are obtained as compared to the group of children without DD. The initial analysis, sensitivity measures are 59% and 74% for right and left ears, and specificity is 89-90% for both.

Operant Characteristics for Visual Pass for TEOAE Screening for Right Ear of Children with Developmental Disabilities

A	96	Sensitivity	59.26
B	53	Specificity	89.87
C	66	Positive Predictive Value	64.43
D	470	Negative Predictive Value	87.69
		False Negative	40.74
N	685	False Positive	10.13
		Over referral	35.57
		Under referral	12.31
		Overall Agreement	82.63

Operant Characteristics for Visual Pass for TEOAE Screening for Left Ear of Children with Developmental Disabilities

A	113	Sensitivity	74.34
B	58	Specificity	89.28
C	39	Positive Predictive Value	66.08
D	483	Negative Predictive Value	92.53
		False Negative	25.66
N	693	False Positive	10.72
		Over referral	33.92
		Under referral	7.47
		Overall Agreement	86.00

When the data are reanalyzed to allow for the presence of negative pressure in the middle ear cavity without concomitant hearing loss, the sensitivity of the visual pass TEOAE protocol is improved for the group of children with DD, too. For the right ear, the sensitivity measure improved from 59% to 86% and for the left ear from 74% to 94%. Under either circumstance, specificity measures were approximately 90%.

Visual Pass for TEOAE Screening for Right Ear of Children with Developmental Disabilities when allowing for Middle Ear Negative Pressure

A	96	Sensitivity	86.49
B	53	Specificity	90.77
C	15	Positive Predictive Value	64.43
D	521	Negative Predictive Value	97.20
		False Negative	13.51
N	685	False Positive	9.23
		Over referral	35.57
		Under referral	2.80
		Overall Agreement	90.07

Visual Pass for TEOAE Screening for Left Ear of Children with Developmental Disabilities when allowing for Middle Ear Negative Pressure

A	113	Sensitivity	94.17
B	58	Specificity	89.70
C	7	Positive Predictive Value	66.08
D	505	Negative Predictive Value	98.63
		False Negative	5.83
N	683	False Positive	10.30
		Over referral	33.92
		Under referral	1.37
		Overall Agreement	90.48

Sensitivity and Specificity of Consortium TEOAE Protocol.

When the sensitivity and specificity operant characteristics of the consortium TEOAE hearing screening protocol are evaluated, it again becomes apparent that the consortium criteria are less conservative than the visual pass criteria earlier discussed. The sensitivity measures are higher for this protocol were higher than those in the visual pass protocol, and the specificity measures are lower, indicating that fewer subjects with abnormal ears passed the hearing screening and more subjects with normal hearing were referred by the consortium criteria.

Right Ear - Consortium TEOAE Protocol for Children without Disabilities

A	14	Sensitivity	58.33
B	82	Specificity	71.63
C	10	Positive Predictive Value	14.58
D	207	Negative Predictive Value	95.39
		False Negative	41.67
N	313	False Positive	28.37
		Over referral	85.42
		Under referral	4.61
		Overall Agreement	70.61

Left Ear - Consortium Screening TEOAE Protocol for Children without Developmental Disabilities

A	24	Sensitivity	80.00
B	87	Specificity	70.31
C	6	Positive Predictive Value	21.62
D	206	Negative Predictive Value	97.17
		False Negative	20.00
N	323	False Positive	29.69
		Over referral	78.38
		Under referral	2.83
		Overall Agreement	71.21

Although differences exist between the results of the sensitivity and specificity measures between the two TEOAE protocols, both demonstrate an improvement in sensitivity when ears with negative middle ear pressure and normal hearing are not considered abnormal. This modification was considered a valid alteration due to the fact that under most circumstances, no referrals for medical attention would be made on the basis of negative pressure alone.

Right Ear - Consortium Criteria on TEOAE for Children without Disabilities when allowing for Negative Middle Ear Pressure

A	14	Sensitivity	93.33
B	82	Specificity	72.48
C	1	Positive Predictive Value	14.58
D	216	Negative Predictive Value	99.54
		False Negative	6.67
N	313	False Positive	27.52
		Over referral	85.42
		Under referral	0.46
		Overall Agreement	73.48

Left Ear - Consortium Criteria on TEOAE for Children without Developmental Disabilities when allowing for Negative Middle Ear Pressure

A	24	Sensitivity	100.00
B	87	Specificity	70.90
C	0	Positive Predictive Value	21.62
D	212	Negative Predictive Value	100.00
		False Negative	0.00
N		False Positive	29.10
		Over referral	78.38
		Under referral	0.00
		Overall Agreement	73.07

For the group of children with DD, sensitivity and specificity measures were 73% and 75% for the right ear, respectively, and 83% and 71% for the left ear, respectively. The consortium protocol, therefore, resulted in higher sensitivity than the visual pass protocol for this group of children. When compared to the Asha screening protocols, the screening was completed for substantially more children with DD.

Consortium Criteria for TEOAE Screening for Right Ear of Children with Developmental Disabilities

A	120	Sensitivity	73.17
B	134	Specificity	74.52
C	44	Positive Predictive Value	47.24
D	392	Negative Predictive Value	89.91
		False Negative	26.83
N	690	False Positive	25.48
		Over referral	52.76
		Under referral	10.09
		Overall Agreement	74.20

Consortium Criteria for TEOAE Screening for Left Ear of Children with Developmental Disabilities

A	127	Sensitivity	83.01
B	156	Specificity	71.38
C	26	Positive Predictive Value	44.88
D	389	Negative Predictive Value	93.73
		False Negative	16.99
N	698	False Positive	28.62
		Over referral	55.12
		Under referral	6.27
		Overall Agreement	73.93

When ears with negative pressure were accounted for, the consortium TEOAE protocol demonstrated marked improvement in sensitivity. Sensitivity measures of 73% for the right ear and 83% for the left ear improved to 96% for each ear. Specificity, however, was 76% and 72%, once again indicating that the consortium protocol has a high percent of over referrals. Overall agreement measures were fair with 80% of the right ear results in agreement and 77% of the left ear results in agreement overall.

Consortium Criteria for TEOAE Screening for Right Ear of Children with Developmental Disabilities when allowing for Middle Ear Negative Pressure

A	120	Sensitivity	96.00
B	134	Specificity	76.28
C	5	Positive Predictive Value	47.24
D	431	Negative Predictive Value	98.85
		False Negative	4.00
N	690	False Positive	23.72
		Over referral	52.76
		Under referral	1.15
		Overall Agreement	79.86

Consortium Criteria for TEOAE Screening for Left Ear of Children with Developmental Disabilities when allowing for Middle Ear Negative Pressure

A	127	Sensitivity	95.49
B	156	Specificity	72.39
C	6	Positive Predictive Value	44.88
D	409	Negative Predictive Value	98.55
		False Negative	4.51
N	698	False Positive	27.61
		Over referral	55.12
		Under referral	1.45
		Overall Agreement	76.79

Cost Effectiveness.

When examining the cost effectiveness of the different hearing screening protocols, there are many factors that must be considered. Each program's overall cost per screening each child is dependent on a wide variety of factors, such as the salary of the personnel completing the hearing screening, the instrumentation and supplies necessary to perform the hearing screening protocol, the time and space requirements for the screenings, the operant characteristics of the screening protocol, and so forth. Several major components of any cost effectiveness discussion were examined in this study, including the operant characteristics of the screening protocol (discussed above), the time required to complete the screening for each child, and the number of children for whom the screening could be completed.

Due to the way that the screeners recorded the time required to complete each screening, complete data are not available for the Asha-B protocol as the time spent in doing otoscopy and tympanometry were not recorded. However, time was recorded for the pure tone portion of the conventional screenings. Overall, TEOAE screenings required more time than the pure tone

screenings for both the group of children without DD and the group of children with DD (see below). As may be anticipated, each of the screening protocols required more time to complete for children with DD than did the same screenings for children without DD. This held true even when the younger children in the group with DD were omitted from the averages.

Average Time Required to Complete Hearing Screening

Subjects	Protocol	Average Time	Standard Deviation
Children without Disabilities (age 5 to 7)	TEOAE	282 sec	141
	Pure Tone	56 sec	29
Children with Disabilities (age 3 to 7)	TEOAE	303 sec	137
	Pure Tone	97 sec	70
Children with Disabilities (age 5 to 7)	TEOAE	289 sec	166
	Pure Tone	90 sec	74

Although TEOAE screenings required more time to complete than the pure tone screenings, the fact that fewer children with DD were able to complete the protocol must be considered. About one third of the children with DD would have required additional testing in order to determine their auditory status using only the conventional screening protocols, whereas only 2% of the same children would have required further screening with the TEOAE screening protocols. Therefore, the costs associated with rescheduling and rescreening or referring the children who were not able to complete the screenings would be dramatically lower for the TEOAE screening.

DISCUSSION

The results of this project prove conclusively that it is feasible to use TEOAE as a screening tool for children ages 3 to 7 with DD. Almost all of the children with DD who participated in this study were able to complete the TEOAE hearing screenings even though they were in the school setting. Traditionally, and as demonstrated in this study, routine pure tone screening programs are typically not successful for determining auditory status for many of the children with DD. Because this group of children, particularly in the age range of 3 to 7, is very often considered "difficult to test", the ability to obtain satisfactory auditory assessment results from the majority of the children is highly problematic. Hence, the TEOAE procedure is an extremely important tool in the audiometric test battery not only for its ability to identify the presence of an educationally significant hearing loss, but also for its ability to confirm that peripheral auditory status is normal.

When the operant characteristics of the four screening protocols evaluated, the Asha-B protocol had the better performance for both groups of children. The sensitivity of the TEOAE protocols that were used in the study, when allowing for the presence of negative middle ear pressure, were comparable to those of the pure tone/immittance (Asha-B) protocol typically used in educational settings, but specificity was lower and resulted in more false positive results. However, even though the same children were tested, fewer participants with DD were able to perform the behavioral tasks necessary to complete the pure tone portion of the conventional screening protocols as compared to the number of children who successfully completed the TEOAE screening protocols.

The TEOAE screening protocols evaluated in this study were successfully completed by almost all children with DD while only about two thirds of the same children could be screened with pure tones. Although completing the TEOAE screenings took longer than the time necessary to complete the pure tone/immittance screening protocol, fewer children would need to be referred for additional testing. In most cases and situations, the necessity of having to rescreen or to cover the costs of audiometric assessments on the children referred for additional audiometric testing would outweigh the cost of spending slightly more time with a student in an educational setting on the initial hearing screening. Thus, the use of the TEOAE procedure with children who have DD, particularly for preschool or kindergarten children who have difficulty with the behavioral screening procedures, is demonstrably warranted and recommended.

Summary of Conclusions

- It is entirely feasible to use TEOAEs as a tool for screening hearing in an educational setting.
- It is entirely feasible to use TEOAEs as a tool for screening for hearing loss in children ages 3 to 7 who have one or more identified DD.
- Greater variability realized for children with DD as compared to a group of subjects without DD.
- Children with DD presented a higher prevalence of hearing loss and middle ear pathology than did the children without DD.
- The operant characteristics of the Asha-B hearing screening protocol were superior to both the Asha-A hearing screening protocol and the TEOAE screening protocols for both groups of subjects. However, for the group of children with DD, pure tone screening results could not be

obtained from nearly one third of the children with DD, whereas successful results were obtained from over 98% of the same children with TEOAE screenings.

Opportunities for Further Analysis

As with most studies of merit, the conclusion of this project has not answered all of the questions regarding the use of TEOAEs as a tool for screening children for hearing loss in educational settings. During the course of data collection and analysis, a number of potential studies have arisen that would prove useful in further defining our knowledge about using TEOAEs with children with no identified pathologies, for younger children and toddlers, for other populations considered "difficult-to-test", and for children with one or more DD. Several of these projects are outlined below.

One key area of investigation would focus on further defining the optimal pass/refer criteria for TEOAE hearing screenings with school-aged children. As a component of such a study, it would be helpful to delineate normative data for designated screening protocols. Some preliminary analyses have been initiated through the data obtained in this study. (The data below present information for one ear of one group only for demonstration purposes). The tables below present information regarding (a) the recording conditions (all of which may be varied to investigate optimal conditions), (b) analyses using signal to noise ratio by bandwidth rather than reproducibility by bandwidth, and © whole wave measures as opposed to investigating TEOAE responses divided into frequency regions.

Recording Conditions for the Right Ear for Children with Developmental Disabilities

Measure	Average	Standard Deviation	Range
Quiet Samples	134.18	80.93	50 - 260
Noisy Samples	88.38	100.56	0 - 1136
Stimulus Peak	80.40	1.615	65 - 85
Stimulus Stability	91.90	10.98	0-100

Right Ear Signal to Noise Ratio for TEOAEs with Children with Disabilities			
Frequency Bandwidth	Signal/Noise Ratio	Standard Deviation	Range
800	2.09	5.0	(5)-18
1600	9.475	6.16	(5) - 27
2400	11.19	5.80	(5)- 28
3200	11.87	6.09	(5) - 30
4000	11.06	6.42	(4)-33

Whole Wave Measures for the Right Ear of Children with Disabilities

Measure	Average	Standard Deviation	Range
A-B Difference	4.85	5.13	-8.4 - 18.0
A&B Mean	11.07	5.22	(5.8) - 23.6
Noise Level	34.48	6.01	22.2 - 49.0
Whole Wave Repro	69.80	26.68	0-99

Additional investigations that would be of benefit to using TEOAEs in an educational setting include:

- further definition regarding how middle ear status affects TEOAE hearing screenings (e.g., for children with varied histories of middle ear pathologies and for children with PE tubes);
- further study on TEOAE norms for children by age group and
- comparisons using persons other than audiologists to complete TEOAE hearing screenings.

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Appendix A: Human Subjects Authorization, Applications for Human Subjects Approval, and Letters of Support from Participants

Utah State University
Utah Department of Special Education
Alpine School District
Box Elder School District
Cache County School District
Davis Count School District
Granite School District
Jordan School District
Logan City School District
Provo City School District
Utah Schools for the Deaf and the Blind
Weber County School District

UTAH STATE UNIVERSITY · LOGAN, UTAH 84322-1450

OFFICE OF THE VICE PRESIDENT
FOR RESEARCH
Telephone (801) 750-1180

MEMORANDUM

TO: Dr. Brandt Culpepper

FROM: Sydney Peterson SP

DATE: December 2, 1993

SUBJECT: Proposal titled, "Investigations of the Clinical Uses of Otoacoustic Emissions with Children and Adults"

The above-referenced proposal has been reviewed and approved by the Institutional Review Board. Please call me at 750-6924 if you have any questions.

sp

Utah State University UMC 1000

Department of Communicative Disorders • Logan, UT 84322-1000 • (801)750-1378 • (801)750-2318 fax

October 13, 1993

Dr. Sydney Peterson
Utah State University
Research and Technology Park
Logan, UT 84322-9600

Re: Human Subject Approval Revision

Dear Dr. Peterson:

Enclosed you will find a copy of the revised Parent Consent Form to be used for data collection approval for the grant entitled "The Efficacy of Transient Evoked Otoacoustic Emissions in Identifying Hearing Loss in Children with Developmental Disabilities". Although I have not yet received written confirmation of your verbal approval pending this revision, I felt that it would be appropriate to submit the revised form for your review. I have also enclosed copies of the research proposal approvals that we have received from Logan and Cache County School Districts.

If you need any further information, please do not hesitate to contact me. I am looking forward to the receipt of the approved forms from the university so that I may distribute copies to the school districts that have requested a copy to be kept on file. Thanks!

Sincerely yours,

Brandt Culpepper

Brandt Culpepper, Ph.D., CCC-A
Assistant Professor, Audiology

UTAH STATE UNIVERSITY • LOGAN, UTAH 84322-1000

DEPARTMENT OF COMMUNICATIVE DISORDERS
Speech-Language-Hearing Center
(801) 750-1375

TEOAE Hearing Screening Project

PARENT/GUARDIAN CONSENT FORM

I agree to have my child, _____,
(child's name)
receive testing using transient evoked otoacoustic emissions (TEOAE) as part of the regular hearing screening program offered by the Cache School District. I understand that participation in the project is voluntary and that I can withdraw my child my child from the project at any time.

_____ ____/____/____
Parent/Guardian Signature **Date**

Project ID#: _____

Professional Education Programs in Speech Language Pathology and Audiology
accredited by the Educational Standards Board of the American Speech-Language-Hearing Association

The Utah State Office of Education
Scott W. Bean
State Superintendent of Public Instruction

UTAH STATE BOARD OF EDUCATION
UTAH STATE BOARD FOR APPLIED TECHNOLOGY EDUCATION

Keith T. Checketts / Chair • C. Grant Hurst Vice Chair
Neola Brown • Donald G. Christensen
Ruth Hardy Funk • Katharine B. Garff • Harold S. Jensen
V. Jay Liechty • Frances H. Merrill

November 1, 1992

Karl White, Ph.D.
Department of Psychology and
Special Education
Utah State University
Logan, Utah 84322-2810

Dear Karl:

As State Director of Special Education for the State of Utah, I offer my strong support for your U. S. Department of Education proposal concerning auditory screening of children with developmental disabilities. I was delighted to hear of your proposal because the children with disabilities in our state deserve the best possible education we can give them, and I believe your project will go far to help provide them with maximum potential for developmental gain.

I am familiar with the Transient Evoted Otoacoustic Emissions Testing (TEOAE) and its promise as a non-invasive audiometric screening device, and think this project will do much to fill a needed service that we cannot provide at this time. Again, I offer my support and help as State Director of Special Education for the State of Utah for this important project, and look forward to the results.

Sincerely,

Stevan J. Kukic, Ph.D., Director
At Risk and Special Education Services

Instructional Services
Steven R. Mecham, Associate Superintendent
250 East 500 South / Salt Lake City, Utah 84111 / (801) 538-7500 / FAX: 538-7521

UTAH STATE UNIVERSITY · LOGAN, UTAH 84322-1000

DEPARTMENT OF COMMUNICATIVE DISORDERS
Speech-Language-Hearing Center
(801) 750-1375

August 25, 1993

Dr. Stevan J. Kukic, Director
At-Risk and Special Education Services
Utah State Office of Education
250 East 500 South
Salt Lake City, UT 84111

Dear Dr. Kukic:

In November 1992, we submitted a field-initiated research grant proposal entitled **The Efficacy of Transient Evoked Otoacoustic Emissions in Identifying Hearing Loss in Children with Developmental Disabilities** to the U.S. Department of Education, Office of Special Education and Rehabilitative Services. In June 1993, we learned that this three-year project (Award #: HO 23C 30039) had been funded with a start date of September 1, 1993.

The proposal was submitted because research suggests that a substantial percentage (estimates range between 32% and 78%) of children with developmental disabilities in the United States have a mild to profound hearing loss. Many of these children remain undiagnosed for years because they are difficult to test using the traditional audiometric procedures. The value of educational and therapeutic programs for children with disabilities and a concomitant hearing loss is severely impaired if the hearing impairment is not correctly identified and treated.

The goals of the project are to (a) identify hearing loss in children with already confirmed disabilities using traditional pure tone audiometric screening and assessment procedures combined with technology developed in the last few years consisting of Transient Evoked Otoacoustic Emissions testing (TEOAE); and (b) compare the sensitivity and specificity of traditional pure tone screening programs with TEOAE testing programs in a group of normal children and a group of children who have been identified as having one or more disability. The TEOAE testing procedure allows for a quick, non-invasive test of cochlear function without assistance from the person who is being evaluated. Such a device, should it prove both cost-efficient and reliable, would allow for early detection of hearing loss in children with developmental disabilities, thereby providing for them a more optimal learning future.

Professional Education Programs in Speech-Language Pathology and Audiology
accredited by the Educational Standards Board of the American Speech-Language-Hearing Association

During the first year of the three-year project we will collect audiological data from a total 250 students with disabilities. At least 50 children in this group will be 3 to 5 years of age; the remainder will be 5 to 7 years old. Prior to initiating the data collection phase of the project, test protocols will be reviewed and scoring protocols will be developed.

Thank you for your letter of support which you provided for this proposal. We look forward to making arrangements with the school districts that agreed to participate and we believe that this project will yield information and practices which will greatly benefit the students in special education programs throughout the state. Thank you again for your support.

Brandt Culpepper, Ph.D., CCC-A
Assistant Professor/Project Co-Director
Dept. of Communicative Disorders
Utah State University
Logan, UT 84322-1000
(801)750-1378

Gary W. Mauk, M.A., CAGS
Project Coordinator
Dept.of Psychology
Utah State University
Logan, UT 84322-2810
(801)750-1182

UTAH STATE UNIVERSITY · LOGAN, UTAH 84322-1000

DEPARTMENT OF COMMUNICATIVE DISORDERS
Speech-Language-Hearing Center
(801) 750-1375

November 9, 1992

Brandt Culpepper, Ph.D.
Department of Communicative Disorders
Utah State University
Logan, Utah 84322-1000

Karl White, Ph.D.
Department of Psychology
Utah State University
Logan, Utah 84322-2810

Dear Drs. Culpepper and White:

I would like to extend my support to the proposed project to investigate the feasibility of using evoked otoacoustic emissions as a screening tool for cochlear dysfuction in children with identified developmental disabilities. Early identification of hearing loss has implications for virtually every aspect of the habilitation and education of children with hearing impairments. Should the use of otoacoustic emissions prove efficient and effective, it could have a widespread impact on the overall prognosis of children with developmental disabilities who also have some degree of hearing impairment.

Sincerely,

Thomas S. Johnson, Professor and Head
Department of Communicative Disorders
Utah State University
Logan, Utah 8422-1000

Professional Education Programs in Speech-Language Pathology and Audiology
accredited by the Educational Standards Board of the American Speech-Language-Hearing Association

LOGAN REGIONAL HOSPITAL

November 10, 1992

Brandt Culpepper, Ph.D.
Department of Communicative Disorders
Utah State University
Logan, Utah 84322-1000

Dear Dr. Culpepper:

We are very supportive of the proposed research investigating the use of evoked otoacoustic emissions as a screening tool for cochlear dysfunction in children with developmental disabilities. Since many of the children served in our department have significant developmental disabilities or are high-risk neonates, the feasibility of providing an efficient and cost-effective screening method is of great interest to us. Current techniques available are time and cost prohibitive. If otoacoustic emission screening procedures prove effective and efficient, they could have significant impact on the ability to provide earlier habilitation services for children with developmental disabilities who also have some degree of hearing impairment.

Sincerely,

Gordon M Olson

Gordon M. Olson, RPT, Director
Physical Medicine and Rehabilitation

Kathryn Snyder Gantz

Kathryn Snyder Gantz, M.Ed., CCC-SLP, Manager
Speech Pathology and Audiology

BEST COPY AVAILABLE

Charles L. Doane, Administrator
1400 North 500 East Logan, Utah 84321 (801) 752-2050
A facility of Intermountain Health Care

RIHAP Rhode Island Hearing Assessment Project
Women and Infants Hospital of Rhode Island
Rhode Island School for the Deaf

November 2, 1992

Karl R. White, Ph.D.
Professor of Psychology and Special Education
Department of Psychology
Utah State University
Logan, Utah 84322-2810

Dear Dr. White:

Since February, 1990 the Rhode Island Hearing Assessment Project (RIHAP) has investigated the feasibility of using Transient Evoked Otoacoustic Emissions (TEOAE) as a universal screening technique at Women & Infants Hospital of Rhode Island. Recently, the Internal Review Board (IRB) accepted the technique as standard of care and consent forms are no longer required. In addition, the Rhode Island legislature passed legislation mandating universal hearing screening with third part reimbursement for this screening. Both of these recent events were prompted by RIHAP's data suggesting that TEOAE's were a quick, easy and valid technique to screen hearing in the newborn population.

RIHAP has been committed to the early identification of hearing loss in all children including children with developmental disabilities. The hard-to-test child as described in your letter of October 21, 1992, would certainly benefit from the additional audiological information TEOAE's would provide. We have found in our diagnostic follow-up program that TEOAE results have enhanced the audiological decision making process.

Your proposal "The Efficacy of Evoked Otoacoustic Emissions in Identifying Hearing Loss in Children with Developmental Disabilities" will provide the additional audiological information regarding the auditory status of these special populations. I would be honored to be a part of this project and strongly support your endeavors.

Sincerely,

Mary Jane Johnson

Mary Jane Johnson
Project Coordinator
RI Hearing Assessment Project

ALPINE SCHOOL DISTRICT

575 North 100 East, American Fork, Utah 84003 (801) 756-8455

Gary V. Keetch, Assistant Superintendent ▲ 7-12 Schools

July 14, 1994

Dr. Brandt Culpepper
Dept. of ComDDE
Utah State University
Logan, UT 84322-1000

Dr. Culpepper,

Thank you for your recent request to conduct research in the Alpine School District related to hearing deficits in developmentally disabled children.

You have my permission to contact Mr. Richard Mecham, Director of Special Education, Alpine School District, prior to contacting the principals of elementary schools in the District. If they give you permission to proceed, you may then contact individual parents.

Again, thank you for your interest in and willingness to research these important issues.

Respectfully,

Frank L. Cameron, Ph.D.
Director, Research and Evaluation

bn

cc: Gary Keetch
Jack Reid
Richard Mecham

Dr. Steven C. Baugh, Superintendent
Board Of Education: Kenneth Sorenson, President ▲ Guy Fugal, Vice-President ▲ Vance Calder ▲ Linda Campbell ▲ J. Blake Evans, D.M.D.

Utah State UNIVERSITY

DEPARTMENT OF COMMUNICATIVE DISORDERS
AND DEAF EDUCATION
Speech-Language-Hearing Center
Logan, Utah 84322-1000
V/TTY: (801) 797-1375
FAX: (801) 797-0221

March 15, 1995

Mr. Richard Mecham
Special Education Director
Alpine School District
575 North 100 East
American Fork, UT 84003

Dear Mr. Mecham:

It was a pleasure to talk to you on the phone yesterday and enclosed please find:
1. A summary count of the number of permissions received from parents and the number of children who who were tested.
2. Results from the hearing test for each child.

If you have any questions, please do not hesitate to call me, and once again your assistance was very much appreciated.

Sincerely,

Yushita Weirather, M.A., CCC-A

American Speech-Language-Hearing Association
Educational Standards Board
• Accredited •
Speech-Language Pathology/Audiology

Program in Education of the Deaf and the Hard of Hearing accredited by the Council on Education of the Deaf

REQUEST FOR PERMISSION TO CONDUCT RESEARCH
IN THE ALPINE SCHOOL DISTRICT

Research and Evaluation reviews all requests to conduct research in the Alpine School District. Please respond to each of the following questions. Use additional paper if necessary. Read the Guidelines prior to filling out this request form.

1. Name of person responsible for conducting research

Brandt Culpepper

Status (student, faculty, etc.) Faculty

Mailing Address Dept. of ComDDE, Utah State University, Logan, UT 84322-1000

Telephones: (home) (801) 755-9339 (work) (801) 797-1378

Highest academic degree which you hold Ph.D.

2. If you are a university student, provide the following:

Department/Committee Chair

Name _____

Department _____

Office telephone _____

University address _____

_____

3. Indicate the reason(s) for conducting the research.

Course requirements _____ What course? _____

Degree requirements _____ What degree? _____

Which institution _____

Professional interest _____

Other Research grant

4. List the school(s) in which you wish to conduct research.

To be arranged - Elementary schools

5. Describe the amount of actual classroom time to be involved in this research. Identify public school personnel who will be involved or affected by the study, describe briefly how each will be involved, and how much of their time will be used. Identify all of those who will be involved.

Child will be tested out of the classroom. It will take approximately 15-20 minutes per child. A contact person will be needed in the district and/or at each school to help identify the sample population. No help will be needed for actual testing.

6. **What specific questions will the research attempt to answer?**

Is transiently evoked otoacoustic emissions (TEOAE) testing a cost-effective method to screen hearing of children with disabilities? Comparison will be made of the sensitivity and specificity of traditional methods and TEOAEs.

7. **Describe the research design.**

Each participant's hearing will be tested using otoscopy, tympanometry, pure-tone screen, pure-tone thresholds, and transiently evoked otoacoustic emissions.

8. **Fully describe the research procedure.**

Letters will be sent to parents that include a consent form and parent information questionnaire. Once consent is received, children will be tested using conventional hearing screening methods including otoscopy, tympanometry, and a pure-tone screen. Additionally, pure-tone thresholds will be obtained and the child will be tested using TEOAEs. If the child cannot complete the protocol in a school setting, they will be (see attached)

9. **Describe the experimental and control/comparison samples, their size and how they will be selected.**

Approximately 150 children between the ages of 3 and 7 who are qualified to receive special services through the school district will be tested. The target population will be identified with the help of district personnel.

10. **What instruments will be used? If these are not readily available or well-known, attach a copy. If a questionnaire/survey is being used, attach a copy.**

Parent Information Questionnaire attached.

11. **How will the confidentiality of student data or of those who participate in the study be assured?**

Data will be coded using a number. At no time will the child's name be used with results, other than to report results of children needing audiological follow-up to the appropriate district personnel.

12. **Attach a copy of the form to be used for securing parental approval.**

13. **Attach a review of the literature relevant to the study.**

8. (continued)

referred for a follow-up evaluation to determine auditory status and results in conjunction with the study. This will be conducted by USU audiologists at no charge to the district or parents. Other necessary follow-up will be referred back to the school district.

Please return a completed copy of this form, along with all supporting documents to:

Frank L. Cameron, Ph.D.
Director of Research and Evaluation
Alpine School District
50 North Center
American Fork, Ut 84003

(801) 756-8464

The Alpine School District is anxious to cooperate with and to facilitate well-designed theoretical and field research. If you have any questions about the research-approval process, or if you would like to discuss your ideas for the study, please call Bonnie Newman (756-8487) and make an appointment.

AGREEMENT

I agree to submit my completed report to the Department of Research and Evaluation by

_____ (date).

I accept the Guidelines as they are outlined. If approval is granted to conduct research in the Alpine School District, I will follow the design and process as I have described it.

_____ _____

Signature Date

Revised 10/88

GUIDELINES FOR CONDUCTING RESEARCH IN
THE ALPINE SCHOOL DISTRICT

Please retain this page for future reference.

1. If you are a university student or a university staff member, obtain necessary institutional permission prior to submitting this form. Attach a copy of such permission. If you are a student, include the name, department and office telephone number of your professor, mentor or committee chairperson.

2. Anyone who conducts research in the District must obtain written approval from the Director of Research and Evaluation.

3. Once permission from the Research Director is granted, the applicant must obtain written, informed permission from those who will be directly involved in the study: principal, teachers and, where appropriate, parents.

4. Permission to deviate from the approved process and design must be secured in writing.

5. When students are tested, interviewed, or required to fill out questionnaires/surveys, it may, depending upon the nature of the study, be necessary to obtain written, informed parental permission. These permission documents should be retained by the researcher for one year.

6. Activities which involve teacher or student participation should be conducted after the first four weeks and before the last six weeks of the school year.

7. Because of the large number of requests to conduct research, undergraduate research projects generally will not be approved.

8. Any media publicity regarding the project must be approved first by the District Research and Evaluation Director.

9. Participation in any research project always must be voluntary at each stage of the study.

10. Information about individual teachers and students must be confidential, and the subjects' right to privacy must be protected. Confidentiality is of paramount importance.

11. Requests to conduct research about religion, family life, sexual practices or preferences, or other controversial issues generally will be denied.

12. A complimentary copy of the completed research is required.

UTAH STATE UNIVERSITY · LOGAN, UTAH 84322-1000

DEPARTMENT OF COMMUNICATIVE DISORDERS
Speech-Language-Hearing Center
(801) 750-1375

May 13, 1994

Frank L. Cameron, Ph.D.
Director of Research and Evaluation
Alpine School District
50 North Center
American Fork, Utah 84003

Dear Dr. Cameron,

In November 1992, we submitted a field-initiated research grant proposal entitled *The Efficacy of Transient Evoked Otoacoustic Emissions in Identifying Hearing Loss in Children with Developmental Disabilities* to the U.S. Department of Education, Office of Special Education and Rehabilitative Services. In June 1993, we learned that this three-year project (Award #: HO 23C 30039) had been funded with a start date of September 1, 1993.

The proposal was submitted because research suggests that a substantial percentage (estimates range between 32% and 78%) of children with developmental disabilities in the United States have a mild to profound hearing loss. Many of these children remain undiagnosed for years because they are difficult to test using the traditional audiometric procedures. The value of educational and therapeutic programs for children with disabilities and a concomitant hearing loss is severely impaired if the hearing impairment is not correctly identified and treated.

The goals of the project are to (a) identify hearing loss in children with already confirmed disabilities using traditional pure tone audiometric screening and assessment procedures combined with technology developed in the last few years consisting of Transient Evoked Otoacoustic Emissions testing (TEOAE); and (b) compare the sensitivity and specificity of traditional pure tone screening programs with TEOAE testing programs in a group of normal children and a group of children who have been identified as having one or more disability. The TEOAE testing procedure allows for a quick, non-invasive test of cochlear function without assistance from the person who is being evaluated. Such a device, should it prove both cost-efficient and reliable, would allow for early detection of hearing loss in children with developmental disabilities, thereby providing for them a more optimal learning future.

During the first year of the three-year project we are collecting audiological data from a total 250 students with disabilities. At least 50 children in this group will be 3 to 5 years

of age; the remainder will be 5 to 7 years old. Prior to initiating the data collection phase of the project, test protocols were reviewed and scoring protocols were developed.

We have been in touch with Tim Humphries and Richard Mecham from your school district and they have expressed interest in participating in this project. We would like to collect data in your district during the school year 1994-1995. We would be testing the 3-7 year olds in your schools who have been identified as having one or more special needs. The screening protocols which are being compared are the conventional pure tone screenings as recommended by the American Speech-Language-hearing Association and the TEOAE screening. Data collected from each child includes otoscopy, tympanometry, pure tone screening, TEOAE screening, and pure tone thresholds for 500-4000 Hz for each ear.

We would also like you to be aware of the service that will be provided to your school district. All behavioral testing necessary to determine the hearing status of each child participating will be offered to the school district and to the parents of the child free of charge. For children from whom we cannot obtain complete test results in the school setting, it will be necessary to refer for testing in an audiometric suite. It will obviously not be feasible for the students in your district to be tested in Logan, so we will try to coordinate with your district program and/or others in your area on this matter. In addition, the instrumentation which will be used in the school district (such as magnifying otoscopes and ultrasonic cleaners) will be donated to the school audiology program. Above all, we will attempt to be as unobtrusive as possible and will take every effort to avoid disrupting ongoing classroom activities.

If you have any questions or need clarification on the proposed project, please do not hesitate to contact me. Thank you!

Sincerely,

Brandt Culpepper, Ph.D., CCC-A
Assistant Professor/Project Co-Director
Dept. of Communicative Disorders
Utah State University
Logan, UT 84322-1000
(801)750-1378

Gary Mauk, M.A., CAGS
Project Coordinator
Dept.of Psychology
Utah State University
Logan, UT 84322-2810
(801)750-1182

BOX ELDER SCHOOL DISTRICT

STEVEN O. LAING, SUPERINTENDENT •

KIRK ALLEN
SPECIAL EDUCATION COORDINATOR

February 17, 1994

Brandt Culpepper Ph.D. CCC-A
Department of Communication Disorders
Utah State University
Logan, UT 84322-1000

Dear Dr. Culpepper,

Box Elder School District will be pleased to participate with you in your "Transient Evoked Otoacoustic Emissions(TEOAE)" testing . We have a good working relationship with the Department of Communicative Disorders and look forward assisting you and the Department with this study.

We welcome you into our district to collect research data. You have the District's permission to conduct hearing tests and any necessary follow-up procedures with students in the district. You will find your work with the parents and children in Box Elder School District an enjoyable experience.

Please let me know when you plan to begin the study so that I can alert the appropriate administrators. Don't hesitate to contact me if I can be of further assistance.

Sincerely yours,

Kirk Allen
Special Education Coordinator

Enclosures

230 West Second South • Brigham City, Utah 84302 • Phone (801) 723-5281

BOX ELDER SCHOOL DISTRICT

ENROLLMENT 1993-94 SCHOOL YEAR

11/24/93

SCHOOL	K	1	2	3	4	5	6	7	8	9	10	11	12	SP.ED.	TOTAL
BEAR RIVER HIGH										383	307	317	261	24	1292
BEAR RIVER MIDDLE							393	393	380					28	1194
BOX ELDER HIGH										522	467	477	420	40	1926
BOX ELDER JUNIOR								573	540					12	1125
BEAR RIVER CITY	31	21	43	23	44	29									191
BUNDERSON	58	51	56	66	63	67	65								426
CENTRAL	52	51	65	45	76	69	63								421
CORINNE	26	25	36	23	26	32	37							1	206
FIELDING	53	63	61	56	67	65									365
FOOTHILL	67	53	64	68	55	73	77							17	474
GARLAND	50	56	52	58	57	53								1	327
GROUSE CREEK	1	3	1	2	2		1		2	2					14
HONEYVILLE	37	39	45	53	43	51	25								293
HOWELL	2	9	9	10	6	8									44
LAKE VIEW	74	45	61	45	64	56	66							19	430
LINCOLN	45	67	67	66	65	60	62							4	436
MCKINLEY	89	88	97	103	101	82								4	564
MOUNTAIN VIEW	49	54	50	52	58	61	71								395
NORTH PARK	77	75	64	59	99	68								17	459
PARK VALLEY	6	5	5	5	8	5	4	4	4	7	3			2	58
PERRY	19	29	23	27	27	30	30								185
SNOWVILLE	8	7	11	7	9	5									47
WILLARD	33	48	31	50	45	59	45								311
EDITH BOWEN	3	1	4	1	7	3									19
VIP HIGH SCHOOL											2	4	2		8
OUT OF STATE		2		1	1	1	4	3	4	1	2	1	3		23
CANYON VIEW												1			1
GRAND TOTAL	780	792	845	820	923	877	943	973	930	915	781	800	686	169	11234

94 [redacted] - self contained programs
84 Preschool Children

95

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90

UTAH STATE UNIVERSITY · LOGAN, UTAH 84322-1000

DEPARTMENT OF COMMUNICATIVE DISORDERS
Speech-Language-Hearing Center
(801) 750-1375

September 9, 1993

Kirk Allen
Coordinator of Special Education
Box Elder School District
230 West 200 South
Brigham City, UT 84302

Dear Mr. Allen:

In November 1992, we submitted a field-initiated research grant proposal entitled **The Efficacy of Transient Evoked Otoacoustic Emissions in Identifying Hearing Loss in Children with Developmental Disabilities** to the U.S. Department of Education, Office of Special Education and Rehabilitative Services. In June 1993, we learned that this three-year project (Award #: HO 23C 30039) had been funded with a start date of September 1, 1993.

The proposal was submitted because research suggests that a substantial percentage (estimates range between 32% and 78%) of children with developmental disabilities in the United States have a mild to profound hearing loss. Many of these children remain undiagnosed for years because they are difficult to test using traditional audiometric procedures. The value of educational and therapeutic programs for children with disabilities and a concomitant hearing loss is severely impaired if the hearing impairment is not correctly identified and treated.

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Professional Education Programs in Speech-Language Pathology and Audiology
accredited by the Educational Standards Board of the American Speech-Language-Hearing Association

children with developmental disabilities, thereby providing for them a more optimal learning future.

During the first year of the three-year project we will collect audiological data from a total 250 students with disabilities. At least 50 children in this group will be 3 to 5 years of age; the remainder will be 5 to 7 years old. Prior to initiating the data collection phase of the project, test protocols will be reviewed and scoring protocols will be developed.

We would like your support in this endeavor and will be contacting you soon regarding the necessary procedures and/or forms for proceeding with this project in your school district. I understand that you have already spoken with Sheryl Spriet, one of our audiologists on the project, and are interested in participating in the project. We will be contacting you soon. In the meantime, if you have any questions or need further clarification about the hearing screenings, please feel free to contact us at one of the numbers listed below. Thank you.

Brandt Culpepper, Ph.D., CCC-A
Assistant Professor/Project Co-Director
Dept. of Communicative Disorders
Utah State University
Logan, UT 84322-1000
(801)750-1378

Gary W. Mauk, M.A., CAGS
Project Coordinator
Dept.of Psychology
Utah State University
Logan, UT 84322-2810
(801)750-1182

UTAH STATE UNIVERSITY · LOGAN, UTAH 84322-1000

DEPARTMENT OF COMMUNICATIVE DISORDERS
Speech-Language-Hearing Center
(801) 750-1375

August 25, 1993

Mr. Jerry Jones, Audiologist
Box Elder School District
230 West 200 South
Brigham City, UT 84302

Dear Mr. Jones:

In November 1992, we submitted a field-initiated research grant proposal entitled **The Efficacy of Transient Evoked Otoacoustic Emissions in Identifying Hearing Loss in Children with Developmental Disabilities** to the U.S. Department of Education, Office of Special Education and Rehabilitative Services. In June 1993, we learned that this three-year project (Award #: HO 23C 30039) had been funded with a start date of September 1, 1993.

The proposal was submitted because research suggests that a substantial percentage (estimates range between 32% and 78%) of children with developmental disabilities in the United States have a mild to profound hearing loss. Many of these children remain undiagnosed for years because they are difficult to test using traditional audiometric procedures. The value of educational and therapeutic programs for children with disabilities and a concomitant hearing loss is severely impaired if the hearing impairment is not correctly identified and treated.

The goals of the project are to (a) identify hearing loss in children with already confirmed disabilities using traditional pure tone audiometric screening and assessment procedures combined with technology developed in the last few years consisting of Transient Evoked Otoacoustic Emissions testing (TEOAE); and (b) compare the sensitivity and specificity of traditional pure tone screening programs with TEOAE testing programs in a group of normal children and a group of children who have been identified as having one or more disability. The TEOAE testing procedure allows for a quick, non-invasive test of cochlear function without assistance from the person who is being evaluated. Such a device, should it prove both cost-efficient and reliable, would allow for early detection of hearing loss in children with developmental disabilities, thereby providing for them a more optimal learning future.

Professional Education Programs in Speech-Language Pathology and Audiology
accredited by the Educational Standards Board of the American Speech-Language-Hearing Association

During the first year of the three-year project we will collect audiological data from a total 250 students with disabilities. At least 50 children in this group will be 3 to 5 years of age; the remainder will be 5 to 7 years old. Prior to initiating the data collection phase of the project, test protocols will be reviewed and scoring protocols will be developed.

We would like your support in this endeavor and will be contacting you soon regarding the necessary procedures and forms for proceeding with this project in your school district.

Brandt Culpepper, Ph.D., CCC-A
Assistant Professor/Project Co-Director
Dept. of Communicative Disorders
Utah State University
Logan, UT 84322-1000
(801)750-1378

Gary W. Mauk, M.A., CAGS
Project Coordinator
Dept.of Psychology
Utah State University
Logan, UT 84322-2810
(801)750-1182

Cache County School District
2063 North 1200 East
North Logan, Utah 84321
(801) 752-3925

September 15, 1993

Brandt Culpepper, Ph.D., CCC-A
Department of Communicative Disorders
Utah State University
Logan, UT 84322-1000

Dear Dr. Culpepper:

I have reviewed your Research Project Summary on transient evoked otoacoustic emissions and accompanying District and University human subjects forms. Parent consent and questionnaire forms have also been received and seem to be in good order. Therefore, you may proceed with your project and I look forward to learning about the results of your research. I very much appreciate your working closely with Steve Jensen, our audiologist. It will greatly lessen the impact on student time out of class. Best wishes for a successful project!

Sincerely yours,

Julie J. Landeen

Julie J. Landeen, Ed.D.
Director of Special Services

cc: Steve Jensen

Cache County School District
Summary of Proposed Research Project

(To be completed by investigator(s) seeking district's participation in research)

The information on this form will assist the district in reviewing the research request, recognizing the value of good research and its impact on educational programs. The researcher is asked to complete this form and furnish any other information as requested as promptly as possible to allow the district to make an informed decision. If more space is required, please attach pages with reference to the question number.

A. Source of Request

1. Principal investigator(s) Brandt Culpepper, Ph.D.

2. Project Title The Efficacy of Transient Evoked Otoacoustic Emissions in Identifying Hearing Loss in Children with Developmental Disabilities

3. Person making request Brandt Culpepper, Ph.D.

   Position (indicate if student) Assistant Professor

   Address Department of Communicative Disorders

   Utah State University, Logan, UT 84322-1000

   Telephone 750-1378

4. This research is: (Check and complete all that apply)

   (a) X faculty/staff research sponsored at

   Utah State University
   (Name of institution or agency)

   (b) _____ conducted in partial fulfillment of requirements for a course or degree.

   Department _____

   Institution _____

   Candidate for following degree _____

   Name of advisor/supervisor _____

   Position _____

5. Support for project: (Check one)

_____ primarily by institution making the request

_____ personal funds of the investigator(s)

__X__ grant or contract from another agency

Name of agency U.S. Department of Education

B. General Project Description

6. Purpose(s) of the research See attached sheet.

7. Outline of procedures (number of schools, total population to be involved, treatment, data to be gathered, etc.)

See attached sheet.

8. Date the investigator plans to initiate the project in the district. Will be coordinated with schedule set by Steven Jensen, District Audiologist

9. Description of student/subjects from this district (number, ages, grade level, etc.)

See attached sheet.

10. Description of information required from district records or personnel, if applicable.

None.

11. Description of procedures involving students, graduates, parents, or district staff (If tests, questionnaires, etc. are used, please furnish copies)

See #7 on attached sheet. Parent/guardian consent letter and information form are also attached.

12. Estimate of total time requirement for each subject. Minimal: Research to be coordinated in conjunction with existing hearing screening program.

C. Benefits and Risks

13. Indicate the benefits likely to result from this research.

Young children with existing developmental disabilities may have previously undetected hearing losses identified. As a result, these children can be referred for appropriate audiological management.

14. What risks, if any, would be involved for participants?

None.

15. (a) Does the sponsoring institution have an Institutional Review Board (IRB) for the protection of human subjects which complies with federal regulations?

X Yes _____ No

(b) If yes,

_____ This project had been approved by the IRB (attach a copy of the IRB decision)

Submitted 8/26/93 X Plans are to submit this project to the IRB before initiating the project in the district. (Please include a copy of the IRB submission form)

D. Agreement

In the event the project is approved, the investigator(s) agree to the following conditions:

1. To adhere to the purpose and procedures of the project as approved by the district and to restrict the use of data gathered in cooperation with the district to this project, unless further approval is obtained.

2. To furnish the district with progress reports upon request.

3. To provide the district with one copy of all publications (articles, reports, etc.) or in the case of a dissertation or thesis, an abstract describing the completed project.

4. To acknowledge the cooperation of the district in any published report of the project

5. To give the district permission to cite the ongoing or completed project in its own publications, with credit to the investigator(s).

6. To comply with the Family Educational Rights and Privacy Act and amendments thereto.

7. To comply with federal regulations for the protection of human subjects.

8. With regard to student data, to report only group data and no information that can be traced directly or by inference to a specified student, or family member; destroy all materials gathered which contain identifiable information after the project is completed.

Brandt Ostrogorsky

Investigator(s) Signature

If student research, signature of advisor

August 25, 1993

Date

Item 6. Research suggests that a substantial percentage (estimates range between 32% and 78%) of children with developmental disabilities in the United States have a mild to profound hearing loss. Many of these children remain undiagnosed for years because they are difficult to test using the traditional audiometric procedures. The value of educational and therapeutic programs for children with disabilities and a concomitant hearing loss is severely impaired if the hearing impairment is not correctly identified and treated.

The goals of the project are to (a) identify hearing loss in children with already confirmed disabilities using traditional audiometric screening and assessment procedures combined with technology developed in the last few years consisting of Transient Evoked Otoacoustic Emissions testing (TEOAE); and (b) compare the sensitivity and specificity of traditional screening programs with TEOAE testing programs in a group of normal children and a group of children who have been identified as having one or more disability. The TEOAE testing procedure allows for a quick, non-invasive test of cochlear function without assistance from the person who is being evaluated. Such a device, should it prove both cost-efficient and reliable, would allow for early detection of hearing loss in children with developmental disabilities, thereby providing for them a more optimal learning future.

Item 7. During the first year of the three-year project Steve Jensen, District Audiologist, and the project audiologists will collect audiological data from a total 250 students with disabilities. At least 50 children in this group will be 3 to 5 years of age; the remainder will be 5 to 7 years old. Prior to initiating the data collection phase of the project, test protocols will be reviewed and scoring protocols will be developed.

Students will be screened according to existing audiological protocols in school districts and will receive additional services of otoscopy, tympanometry, and TEOAEs. Pure-tone thresholds will be obtained for each child and follow-up referrals will be made as deemed necessary.

Audiological equipment not used in school (e.g., ultrasonic cleaner, updated audiological equipment for otoscopy) will be donated to the school district's hearing screening program at the completion of the project. Follow-up testing for children on whom data audiological data cannot be gathered in the school setting will be provided free of charge to the school district and parents/guardians by the Utah State University Speech-Language-Hearing Center. A record of the final hearing status of each child screened and/or followed up will be provided to Steven Jensen for placement in appropriate school district files.

Item 9. During the first year of the project a total 250 students with disabilities will be audiologically screening in participating school districts. At least 50 children in this group will be 3 to 5 years of age; the remainder will be 5 to 7 years old. Prior to initiating the data collection phase of the project, test protocols will be reviewed and scoring protocols will be developed.

TEOAE Hearing Screening Project

PARENT INFORMATION QUESTIONNAIRE

This sheet is two-sided. Please provide us with the following information to the best of your knowledge on both sides of this sheet. In our records, this information will only be accessible by an identification number to which no names will be linked.

Child's Name: _____ **Grade:** _____ **Date of Birth:** ___/___/___

Child's Gender (circle): Male Female

Developmental Information

At birth or soon after (1 month), did your child have any of the following (check all that apply and circle when applicable)?

___ **Family history of childhood hearing loss**
___ **Maternal infection such as (please circle all that apply):**

Cytomegalovirus (CMV) *Rubella* *Toxoplasmosis* *Syphilis*

___ **Malformations of the face or outer ear or ear canal**
___ **Birth weight less than 3 lbs., 5 oz.**
___ **Jaundice which required a transfusion**
___ **Bacterial meningitis**

After 1 month of age until present (check all that apply):

___ **Do you or other caregivers have concern about your child's hearing, speech, or language?**
___ **Has your child sustained a head trauma involving loss of consciousness or skull fracture?**
___ **Has your child had any of the following childhood diseases (circle all that apply)?**

Bacterial Meningitis *Mumps* *Chicken Pox* *Cytomegalovirus (CMV)*

Previous Hearing Test Information

Has your child had his or her hearing tested before? ___ Yes ___ No

Were you informed that your child had a hearing problem? ___ Yes ___ No

If the results of the hearing testing indicated that your child had a hearing problem, what were the recommendations, if any, of the person who tested your child's hearing?

_____

_____

**** Please Turn This Sheet Over ****

STATEMENT OF PI TO THE IRB FOR PROPOSED
RESEARCH INVOLVING HUMAN SUBJECTS

Proposal Title The Efficacy of Transient Evoked Otoacoustic Emissions in Identifying Hearing Loss in Children with Developmental Disabilities

Primary Researcher Brandt Culpepper, Ph.D./Karl White, Ph.D. Dept. Comm Dis Ext. 1378

Student Researcher* _____ Dept. _____ Ext. ____

A. In this research human subjects will perform the following activities: Subjects will be screened according to existing audiological protocols in school districts and will receive additional services of otoscopy, tympanometry, and TEOAEs. Pure-tone thresholds will be obtained for each child and follow-up referrals will be made as deemed necessary.

B. The potential benefits to be gained from the proposed research are: Improved audiological services will be established for children in participating local school districts and throughout educational systems nationally.

C. The risk(s) to the rights and welfare of human subjects involved are: None.

D. The following safeguards/measures to mitigate/minimize the identified risks will be taken: No names will be recorded on data sheets. Follow-up referral letters for services outside of the project will be kept separately and will be tracked by educational audiologists.

E. The Informed Consent procedures for subjects will be as follows: (Explain procedures to be followed and attach an example of the informed consent instrument):
Participation by the primary caregivers will be voluntary (see attached parent/guardian informed consent letter and information form).

F. The following measures regarding confidentiality of subjects will be taken: Data will be collected without any identifying information from subjects and numerically coded in a secured electronic data file.

G. Other (If, in your opinion no, or minimal, risk to subjects exists, please explain in this section): None.

BEST COPY AVAILABLE

Brandt Culpepper
PI Signature

Student Researcher* Signature

*If Applicable

PARENT INFORMATION QUESTIONNAIRE

This sheet is two-sided. Please provide us with the following information to the best of your knowledge on both sides of this sheet. In our records, this information will only be accessible by an identification number to which no names will be linked.

Child's Name: _____ **Grade:** _____ **Date of Birth:** ___/___/___

Child's Gender (circle): Male Female

Developmental Information

At birth or soon after (1 month), did your child have any of the following (check all that apply and circle when applicable)?

___ **Family history of childhood hearing loss**
___ **Maternal infection such as (please circle all that apply):**

Cytomegalovirus (CMV) *Rubella* *Toxoplasmosis* *Syphilis*

___ **Malformations of the face or outer ear or ear canal**
___ **Birth weight less than 3 lbs., 5 oz.**
___ **Jaundice which required a transfusion**
___ **Bacterial meningitis**

After 1 month of age until present (check all that apply):

___ **Do you or other caregivers have concern about your child's hearing, speech, or language?**
___ **Has your child sustained a head trauma involving loss of consciousness or skull fracture?**
___ **Has your child had any of the following childhood diseases (circle all that apply)?**

Bacterial Meningitis *Mumps* *Chicken Pox* *Cytomegalovirus (CMV)*

Previous Hearing Test Information

Has your child had his or her hearing tested before? ___ Yes ___ No

Were you informed that your child had a hearing problem? ___ Yes ___ No

If the results of the hearing testing indicated that your child had a hearing problem, what were the recommendations, if any, of the person who tested your child's hearing?

_____

_____

**** Please Turn This Sheet Over ****

PARENT INFORMATION QUESTIONNAIRE
(continued)

Ear Infection Information

Is your child prone to frequent ear infections? ___ Yes ___ No

If "Yes," about how many ear infections does your child have per year? _____

When was the last ear infection? _____

How have the infections been treated? _____

_____

In which ear(s) has your child had ear infections?

____ Right Ear ____ Left Ear ____ Both Ears

Has or does your child have PE tubes in his or her ear(s)? ___ Yes ___ No

If "Yes," please check the ear(s) in which your child has had or has PE tubes:

____ Right Ear ____ Left Ear ____ Both Ears

COMMENTS

_____

_____

_____

_____

Thank You For Participating!

Project ID#: _____

Date: ___/___/___

Dear Parent/Guardian of _____,

As a part of the regular hearing screening program offered by the Cache School District, the Department of Communicative Disorders at Utah State University would like your permission to administer a new hearing test to your child as part of a project sponsored by the U.S. Department of Education. The project will be comparing two types of tests used to screen the hearing of children in schools to determine which test is better for the school hearing screening program. In addition to the hearing tests regularly administered to students, we would like to administer a test called transient evoked otoacoustic emissions (TEOAE). The TEOAE test involves placement of a small earphone into each of your child's ears and presenting a series of clicks. These clicks are received back from your child's inner ear through a small microphone contained within the earphone and relayed to a portable computer. The TEOAE test can provide the school audiologist with important additional information about your child's hearing.

Participation of your child in this hearing screening project is voluntary and there are no risks to your child. If you agree to have your child's hearing screened using the TEOAE procedure, please sign the enclosed consent form and return it with a completed "Parent Information Questionnaire" (also attached) in the self-addressed, postage-paid envelope provided. If you have any questions about this research, please call Mr. Steve Jensen, District Audiologist at 753-2100. Thank you for your time and consideration, and we hope you will agree to participate in this project.

Sincerely,

Steven Jensen District Audiologist	Brandt Culpepper USU Audiologist

Enclosures

TEOAE Hearing Screening Project

PARENT/GUARDIAN CONSENT FORM

I agree to have my child, _____,
(child's name)
receive testing using transient evoked otoacoustic emissions (TEOAE) as part of the regular hearing screening program offered by the Cache School District.

_____ ___/___/___
Parent/Guardian Signature Date

Project ID#: _____

Date: ___/___/___

Dear Parent/Guardian:

In a few days, your child will be bringing home a letter and parent consent form. The letter will request your participation in a hearing screening project conducted by the Department of Communicative Disorders at Utah State University as part of the regular hearing screening program offered by the Logan School District.

Participation of your child in the hearing screening project is voluntary and there are no risks to your child. However, the project could provide valuable information about your child's hearing. Additionally, if you were to have to pay for these services, the cost would be approximately $75.00. When you receive the letter and consent form, please consider participating. Thank you for your time and consideration.

Sincerely,

Steven Jensen	Brandt Culpepper
District Audiologist	USU Audiologist

Date: ___/___/___

Dear Parent/Guardian of _____,

As a part of the regular hearing screening program offered by the Logan School District, the Department of Communicative Disorders at Utah State University would like your permission to administer a new hearing test to your child as part of a project sponsored by the U.S. Department of Education. The project will be comparing two types of tests used to screen the hearing of children in schools in schools to determine which test is better for the school hearing screening program. In addition to the hearing tests regularly administered to students, we would like to administer a test called transient evoked otoacoustic emissions (TEOAE). The TEOAE test involves placement of a small earphone into each of your child's ears and presenting a series of clicks. These clicks are received back from your child's inner ear through a small microphone contained within the earphone and relayed to a portable computer. The TEOAE test can provide the school audiologist with important additional information about your child's hearing.

Participation of your child in this hearing screening project is voluntary and there are no risks to your child. If you agree to have your child's hearing screening using the TEOAE procedure, please sign the enclosed consent form and return the consent form with a completed "Parent Information Questionnaire" (also attached) in the self-addressed, postage-paid envelope provided. If you have any questions about this project, please call Steve Jensen, District Audiologist, at 753-2100. Thank you for your time and consideration, and we hope you will agree to participate in this project.

Sincerely,

Steven Jensen District Audioloigst	Brandt Culpepper USU Audiologist

Enclosures

TEOAE Hearing Screening Project

PARENT/GUARDIAN CONSENT FORM

I agree to have my child, _____,
(child's name)
receive testing using transient evoked otoacoustic emissions (TEOAE) as part of the regular hearing screening program offered by the Logan School District.

_____ ___/___/___Parent/Guardian
Signature **Date**

Project ID#: _____

UTAH STATE UNIVERSITY · LOGAN, UTAH 84322-1000

DEPARTMENT OF COMMUNICATIVE DISORDERS
Speech-Language-Hearing Center
(801) 750-1375

August 25, 1993

Dr. Julie J. Landeen
Director of Special Education
Cache County School District
2063 North 1200 East
North Logan, UT 84321

Dear Dr. Landeen:

In November 1992, we submitted a field-initiated research grant proposal entitled **The Efficacy of Transient Evoked Otoacoustic Emissions in Identifying Hearing Loss in Children with Developmental Disabilities** to the U.S. Department of Education, Office of Special Education and Rehabilitative Services. In June 1993, we learned that this three-year project (Award #: HO 23C 30039) had been funded with a start date of September 1, 1993.

The proposal was submitted because research suggests that a substantial percentage (estimates range between 32% and 78%) of children with developmental disabilities in the United States have a mild to profound hearing loss. Many of these children remain undiagnosed for years because they are difficult to test using the traditional audiometric procedures. The value of educational and therapeutic programs for children with disabilities and a concomitant hearing loss is severely impaired if the hearing impairment is not correctly identified and treated.

The goals of the project are to (a) identify hearing loss in children with already confirmed disabilities using traditional pure tone audiometric screening and assessment procedures combined with technology developed in the last few years consisting of Transient Evoked Otoacoustic Emissions testing (TEOAE); and (b) compare the sensitivity and specificity of traditional pure tone screening programs with TEOAE testing programs in a group of normal children and a group of children who have been identified as having one or more disability. The TEOAE testing procedure allows for a quick, non-invasive test of cochlear function without assistance from the person who is being evaluated. Such a device, should it prove both cost-efficient and reliable, would allow for early detection of hearing loss in children with developmental disabilities, thereby providing for them a more optimal learning future.

Professional Education Programs in Speech-Language Pathology and Audiology
accredited by the Educational Standards Board of the American Speech-Language-Hearing Association

During the first year of the three-year project we will collect audiological data from a total 250 students with disabilities. At least 50 children in this group will be 3 to 5 years of age; the remainder will be 5 to 7 years old. Prior to initiating the data collection phase of the project, test protocols will be reviewed and scoring protocols will be developed.

We have been in touch with Steve Jensen from your school district and he has expressed interest in participating in this project. All efforts will be made to coordinate with the existing screening schedule when possible. All necessary human subject and proposed research forms have been submitted for approval. We would like your support in this endeavor and will be contacting you soon regarding the necessary procedures for proceeding with this project in your school district.

We would also like you to be aware of the service that will be provided to your school district. All behavioral testing necessary to determine the hearing status of each child participating will be offered to the school district and to the parents of the child free of charge. For test results which cannot be obtained in the school setting, children will be referred to the Speech-Language-Hearing Center at Utah State University. In addition, the advanced instrumentation which will be used in the school district (such as magnifying otoscopes and ultrasonic cleaners) will be donated to the school audiologist. Above all, we will attempt to be as unobtrusive as possible and will take every effort to avoid disrupting ongoing classroom activities.

If you have any questions or need clarification on the proposed project, please do not hesitate to contact me. Thank you!

Sincerely,

Brandt Culpepper, Ph.D., CCC-A
Assistant Professor/Project Co-Director
Dept. of Communicative Disorders
Utah State University
Logan, UT 84322-1000
(801)750-1378

Gary Mauk, M.A., CAGS
Project Coordinator
Dept. of Psychology
Utah State University
Logan, UT 84322-2810
(801)750-1182

cc: Steve Jensen, Audiologist

Cache County School District
2063 North 1200 East
North Logan, Utah 84321
(801) 752-3925

November 2, 1992

Karl R. White, Ph.D.
Professor of Psychology and Special Education
Department of Psychology
Utah State University
Logan, UT 84322-2810

Dear Karl:

Thank you for the invitation to participate in your project on Transient Evoked Otoacoustics Emissions (TEOAE) testing. Since you last submitted your proposal for funding, we have hired a different audiologist for our District. He is Steve Jensen and he is already using the TEOAE testing with our students with disabilities for the very reasons you have stated in your letter. For this reason and because Mr. Jensen's time with the District is limited, we would not be interested in project involvement at this time. We do appreciate being considered, however; and wish you the best of luck with the resubmission of your proposal.

Sincerely,

Julie

Julie J. Landeen, Ed.D.
Director of Special Services

JJL:dp

UTAH STATE UNIVERSITY · LOGAN, UTAH 84322-1000

DEPARTMENT OF COMMUNICATIVE DISORDERS
Speech-Language-Hearing Center
(801) 750-1375

September 9, 1993

Terry Clawson, Audiologist
70 South 500 East
Farmington, UT 84050

Dear Mr. Clawson:

In November 1992, we submitted a field-initiated research grant proposal entitled **The Efficacy of Transient Evoked Otoacoustic Emissions in Identifying Hearing Loss in Children with Developmental Disabilities** to the U.S. Department of Education, Office of Special Education and Rehabilitative Services. In June 1993, we learned that this three-year project (Award #: HO 23C 30039) had been funded with a start date of September 1, 1993.

The proposal was submitted because research suggests that a substantial percentage (estimates range between 32% and 78%) of children with developmental disabilities in the United States have a mild to profound hearing loss. Many of these children remain undiagnosed for years because they are difficult to test using traditional audiometric procedures. The value of educational and therapeutic programs for children with disabilities and a concomitant hearing loss is severely impaired if the hearing impairment is not correctly identified and treated.

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Professional Education Programs in Speech-Language Pathology and Audiology
accredited by the Educational Standards Board of the American Speech-Language-Hearing Association

During the first year of the three-year project we will collect audiological data from a total 250 students with disabilities. At least 50 children in this group will be 3 to 5 years of age; the remainder will be 5 to 7 years old. Prior to initiating the data collection phase of the project, test protocols will be reviewed and scoring protocols will be developed.

We would like your support in this endeavor and will be contacting you soon regarding the necessary procedures and/or forms for proceeding with this project in your school district. I understand that you have already spoken with Sheryl Spriet, one of our audiologists on the project, and are interested in participating in the project. We will be contacting you soon. In the meantime, if you have any questions or need further clarification about the hearing screenings, please feel free to contact us at one of the numbers listed below. Thank you.

Brandt Culpepper, Ph.D., CCC-A
Assistant Professor/Project Co-Director
Dept. of Communicative Disorders
Utah State University
Logan, UT 84322-1000
(801)750-1378

Gary W. Mauk, M.A., CAGS
Project Coordinator
Dept.of Psychology
Utah State University
Logan, UT 84322-2810
(801)750-1182

Granite School District
340 East 3545 South — Salt Lake City, Utah 84115

Application for Permission to Conduct Research Study

(Note: A copy of the **Research Proposal** and a copy of the **Instrument** must accompany each application.)

(PLEASE TYPE)

Permission will not be granted to conduct research after April 1.

Title: The Efficacy of Transient Evoked Otoacoustic Emissions in Identifying Hearing Loss in Children with Developmental Disabilities Date: October 13, 1993

Researcher: Brandt Culpepper, Ph.D./Karl White, Ph.D., Utah State Univ. 84322-1000 750-1378
(Name) (Address) (Zip) (Telephone)

Sponsoring Institution: Utah State University Communicative Disorders
(University/Organization) (Department) (Chairperson)

Anticipated dates district would be involved: January - February 1994

Reason for study (Master's Thesis, Doctoral Study, other): Research Grant

The following Granite District personnel and facilities would be needed:

Number of Students	Grade	School	Teacher (if known)
300	k - 3	To be arranged by Judy Farmer	

Teachers: _____ Counselors: _____ Principals: _____ Dist. Office Staff: _____ Patrons: _____

Time required of students: 15 minutes Time required of others: Coordination of Testing

Instruments to be used (attach copy):

Instrument: N/A Administration Time: _____

Who will administer the instrument? Clinical Audiologists with Masters Degrees

Will written parent permission be required? [X] Yes [ ] No

If yes, state how it is to be obtained and attach copy of parent letter. First letter to be sent home with child; second letter, parent consent form, and parent questionnaire to be mailed

District facilities/equipment/supplies requested: 1 - 2 small rooms for testing; audiology suite as needed for follow up

Research Study Subject to Review by Appropriate Division

Assistant Superintendent
Elementary School Services:

Approved: [signature]

Date: 10/27/93

Deputy Superintendent
Secondary School Services:

Approved: [signature]

Date: 10-25-93

Final Approval — Superintendent: [signature] Date: 10-28-93

Project Number: 1993-94 1.3

Copy Distribution: WHITE — Research Applicant **YELLOW** — School Principal **PINK** — Superintendent's Office

GSD Form: 014/02/08-92

UTAH STATE UNIVERSITY · LOGAN, UTAH 84322-1000

DEPARTMENT OF COMMUNICATIVE DISORDERS
Speech-Language-Hearing Center
(801) 750-1375

Date: 12/7/93

Dear Parent/Guardian:

In a few days, your child will be bringing home a letter and parent consent form. The letter will request your participation in a hearing screening project conducted by the Department of Communicative Disorders at Utah State University. The hearing screening project is part of a research grant that will be conducted in part in the Granite School District. This grant has been approved by Superintendent Burton of the Granite School District.

Participation of your child in the hearing screening project is voluntary and there are no risks to your child. However, the project may provide valuable information about your child's hearing. When you receive the letter and consent form, please consider participating. Thank you for your time and consideration.

Sincerely,

Judy Farmer
Coordinator of Hearing Services
Granite School District

Brandt Culpepper
USU Audiologist

Professional Education Programs in Speech-Language Pathology and Audiology
accredited by the Educational Standards Board of the American Speech-Language-Hearing Association

UTAH STATE UNIVERSITY · LOGAN, UTAH 84322-1000

DEPARTMENT OF COMMUNICATIVE DISORDERS
Speech-Language-Hearing Center
(801) 750-1375

Date: 12/9/93

Dear Parent/Guardian:

As a part of a research project being conducted in the Granite School District, the Department of Communicative Disorders at Utah State University would like your permission to administer a new hearing test to your child, as well as traditional hearing screening tests, as part of a project sponsored by the U.S. Department of Education. The project will be comparing two types of tests used to screen the hearing of children in schools to determine which test is better for the school hearing screening program. In addition to the hearing tests regularly administered to students, we would like to administer a test called transient evoked otoacoustic emissions (TEOAE). TEOAE test involves placement of a small earphone to each of your child's ears and presenting a series of clicks. These clicks are received back from your child's inner ear through a small microphone contained within the earphone and relayed to a portable computer. The TEOAE test may provide the school audiologist with important additional information about your child's hearing.

Participation of your child in this hearing screening project is voluntary and there are no risks to your child. If you agree to have your child's hearing screening using the TEOAE procedure, as well as traditional screening methods, please sign the enclosed consent form and return the it with a completed "Parent Information Questionnaire" (also attached) in the self-addressed, postage-paid envelope provided. The information provided by the questionnaire and additional information that will be obtained from the district, will help us determine if the new test is beneficial for all children. At no time will your child's name be used for research purposes. It will only be used to provide information back to the hearing specialists in Granite School District so appropriate follow-up services can be provided for your child if needed. If you have any questions about this project, please contact Judy Farmer at 481-7111. Thank you for your time and consideration, and we hope you will agree to have your child participate in this project.

Please return the Consent Form and Parent Information Questionnaire by 12/31/93 in the envelope provided.

Sincerely,

Judy Farmer
Coordinator of Hearing Services
Granite School District

Brandt Culpepper
USU Audiologist

Enclosures

UTAH STATE UNIVERSITY · LOGAN, UTAH 84322-1000

DEPARTMENT OF COMMUNICATIVE DISORDERS
Speech-Language-Hearing Center
(801) 750-1375

TEOAE Hearing Screening Project

PARENT/GUARDIAN CONSENT FORM

I agree to have my child, _____,
(child's name)
receive testing using transient evoked otoacoustic emissions (TEOAE), pure tone screening, pure tone threshold testing, immittance testing, and otoscopy as part of the research project conducted by the Department of Communicative Disorders at Utah State University in the Granite School District. I also give permission for release of information provided on the Parent Information Questionnaire and for release of information regarding any disability.

I understand that this information will be kept confidential and at no time will my child's name be used for research purposes. I also understand that participation in the project in voluntary and that I can withdraw my child from the project at any time.

_____ ____/____/____
Parent/Guardian Signature Date

Project ID#: _____

Professional Education Programs in Speech-Language Pathology and Audiology
accredited by the Educational Standards Board of the American Speech-Language-Hearing Association

UTAH STATE UNIVERSITY · LOGAN, UTAH 84322-1000

DEPARTMENT OF COMMUNICATIVE DISORDERS
Speech-Language-Hearing Center
(801) 750-1375

August 25, 1993

Ms. Judy Farmer
Coordinator of Hearing Services
Granite School District
Student Support Services
3031 South 200 East
Salt Lake City, UT 84115

Dear Ms. Farmer:

In November 1992, we submitted a field-initiated research grant proposal entitled **The Efficacy of Transient Evoked Otoacoustic Emissions in Identifying Hearing Loss in Children with Developmental Disabilities** to the U.S. Department of Education, Office of Special Education and Rehabilitative Services. In June 1993, we learned that this three-year project (Award #: HO 23C 30039) had been funded with a start date of September 1, 1993.

The proposal was submitted because research suggests that a substantial percentage (estimates range between 32% and 78%) of children with developmental disabilities in the United States have a mild to profound hearing loss. Many of these children remain undiagnosed for years because they are difficult to test using the traditional audiometric procedures. The value of educational and therapeutic programs for children with disabilities and a concomitant hearing loss is severely impaired if the hearing impairment is not correctly identified and treated.

The goals of the project are to (a) identify hearing loss in children with already confirmed disabilities using traditional pure tone audiometric screening and assessment procedures combined with technology developed in the last few years consisting of Transient Evoked Otoacoustic Emissions testing (TEOAE); and (b) compare the sensitivity and specificity of traditional pure tone screening programs with TEOAE testing programs in a group of normal children and a group of children who have been identified as having one or more disability. The TEOAE testing procedure allows for a quick, non-invasive test of cochlear function without assistance from the person who is being evaluated. Such a device, should it prove both cost-efficient and reliable, would allow for early detection of hearing loss in children with developmental disabilities, thereby providing for them a more optimal learning future.

Professional Education Programs in Speech-Language Pathology and Audiology
accredited by the Educational Standards Board of the American Speech-Language-Hearing Association

During the first year of the three-year project we will collect audiological data from a total 250 students with disabilities. At least 50 children in this group will be 3 to 5 years of age; the remainder will be 5 to 7 years old. Prior to initiating the data collection phase of the project, test protocols will be reviewed and scoring protocols will be developed.

We would like your support in this endeavor and will be contacting you soon regarding the necessary procedures and forms for proceeding with this project in your school district.

Brandt Culpepper, Ph.D., CCC-A
Assistant Professor/Project Co-Director
Dept. of Communicative Disorders
Utah State University
Logan, UT 84322-1000
(801)750-1378

Gary W. Mauk, M.A., CAGS
Project Coordinator
Dept.of Psychology
Utah State University
Logan, UT 84322-2810
(801)750-1182

cc: Steve Jensen, Audiologist

GRANITE SCHOOL DISTRICT
STUDENT SUPPORT SERVICES
3031 SOUTH 200 EAST • SALT LAKE CITY, UTAH 84115 • PHONE (801) 481-7110

November 2, 1992

Karl White, Ph.D.
Professor of Psychology in Special Education
Utah State University
Logan, Utah 84322-2810

Dear Dr. White,

The Granite School District hearing department is very interested in the project that you are proposing concerning hearing testing of difficult to test children using the Transient Evoked Otoacoustic Emissions testing. If a student is having school problems with an associated undiagnosed hearing loss, he/she could be placed in an inappropriate program. There is a critical need of finding ways to accurately test the hearing of this population.

Sincerely,

Judy Farmer
Coordinator
Speech, Hearing, Vision
Granite School District

JF:ttc

Board of Education
Jordan School District
Dr. Raymond W. Whittenburg – Superintendent of Schools
9361 South 300 East – Sandy, Utah 84070-2998
Phone (801) 567-8100 – FAX (801) 567-8000

Barry L. Newbold, Ed.D.
Director of Program Services and Evaluation
Phone (801) 567-8334
FAX (801) 567-8040

April 29, 1994

Brandt Culpepper, Ph.D.
Karl White, Ph.D.
Utah State University
Department of Communicative Disorders
Logan, Utah 84322-1000

Dear Dr. Culpepper and Dr. White,

Your request to conduct a research project in the Jordan School District concerning "The Efficacy of Transiently Evoked Otoacoustic Emissions (TEOAEs) in Identifying Hearing Loss in Children with Developmental Disabilities" has been approved by the District Research Review Committee.

Although you have received Research Committee approval, this decision does not obligate a school and its staff to participate if circumstances or events are such that the research would create problems or would be overly burdensome. Notification of approval from the Research Review Committee will be sent to Becky Almerico at the District office, who will coordinate. It will then be necessary for you to personally contact the principal(s) to formalize your request and to explain further the purpose and extent of your research.

We desire that you will be successful in this endeavor and extend to you our assistance as may be needed, and will be happy to answer any further questions. Please send a copy of your final written findings, conclusions, and recommendations from the study to Dr. Barry L. Newbold at the Jordan School District office.

Sincerely,

Dr. Barry L. Newbold, Chairman
Research Review Commitee

Board of Education

Jordan School District

Dr. Raymond W. Whittenburg – Superintendent of Schools
9361 South 300 East – Sandy, Utah 84070-2998
Phone (801) 567-8100 – FAX (801) 567-8000

Barry L. Newbold, Ed.D.
Director of Program Services and Evaluation
Phone (801) 567-8334
FAX (801) 567-8040

Research Applicant:

The Jordan District Board of Education and Administration encourage and support the conducting of research that provides information and data which can be useful in improving District operational and instructional programs. However, to insure that proposed research projects are appropriate and have educational value to the District, a Research Review Committee has been established to review and approve research requests.

The guidelines for submitting and receiving approval of a proposed research project are found on the following pages.

Sincerely,

Dr. Barry L. Newbold, Chairman
Research Review Committee

JORDAN SCHOOL DISTRICT
Dr. Raymond W. Whittenburg- Superintendent of Schools
Sandy, Utah 84070

RESEARCH PROJECTS APPROVAL GUIDELINES

1. Prior to conducting a research project in Jordan School District, approval must be obtained from the District Research Review Committee.

2. To initiate the review process, a Research Project Application must be completed and submitted to the Director of Program Services and Evaluations.

3. Research Project applications must be accompanied by a project proposal and must include a copy of the instruments that will be used.

4. Research projects that require the participation of teachers and/or students during the first two weeks or the last thirty days of the school year generally will not be approved.

5. Research proposal approval generally will be limited to those projects that complete the requirements associated with a graduate thesis, dissertation or practicum.

6. Applications, to be considered by the Research Review Committee at their next meeting, must be received at least ten days prior to the date of the meeting.

7. Approval of the Research Project Application by the Research Review Committee authorizes the applicant to proceed with the research. However, Research Review Committee approval does not necessarily obligate the participation of any school or employee of Jordan School District.

8. Following Committee approval of the project, no changes in methodology or instrumentation may be made unless approved by the Research Review Committee.

9. Upon completion of the research project, a copy is to be submitted to the Director of Program Services and Evaluation to be added to the District's Research Library.

Utah State UNIVERSITY

DEPARTMENT OF COMMUNICATIVE DISORDERS
AND DEAF EDUCATION
Speech-Language-Hearing Center
Logan, Utah 84322-1000
V/TTY: (801) 797-1375
FAX: (801) 797-0221

TEOAE Hearing Screening Project

PARENT/GUARDIAN CONSENT FORM

I agree to have my child, _____,
(child's name)
receive testing using the computerized hearing test (TEOAE), pure tone screening, pure tone threshold testing, immittance testing, and otoscopy as part of the research project conducted by the Department of Communicative Disorders at Utah State University in Jordan School District. I also give permission for release of information provided on the Parent Information Questionnaire and for release of information regarding any disability.

I understand that this information will be kept confidential and at no time will my child's name be used in conjunction with any results obtained, except to provide the district with information necessary for follow up testing if a hearing problem is suspected. I also understand that participation in the project is voluntary and that I can withdraw my child from the project at any time.

_____ ___/___/___
Parent/Guardian Signature **Date**

Project ID#: _____

American Speech-Language-Hearing Association
Educational Standards Board
• Accredited •
Speech-Language Pathology/Audiology

Program in Education of the Deaf and the Hard of Hearing accredited by the Council on Education of the Deaf

LOGAN CITY SCHOOL DISTRICT
101 WEST CENTER LOGAN, UTAH 84321-4563
PHONE 801-755-2300
FAX NUMBER 801-755-2311

MYRA LYNCH
Personnel Director

September 7, 1993

Dr. Brandt Culpepper
Dept. of Communicative Disorders
Utah State University
Logan, UT 84322-1000

Dear Dr. Culpepper,

We have received your request to conduct research in Logan City School District. The review committee has carefully considered your proposal and will grant permission for your study to be conducted in the Logan City School District.

Please work with Dr. Debra Cheney, Director of Special Services, on the specific details of the project.

Please feel free to contact us if you need further assistance.

Sincerely,

Myra Lynch
Personnel Director

ML:eo

cc: Dr. Debra Cheney
Mr. Steve Jensen

LOGAN CITY SCHOOLS
RESEARCH APPLICATION

Date _____

RESEARCH INFORMATION:

1. Person doing research Brandt Culpepper, Ph.D.
2. Mailing address Utah State University, Dept. of Communicative Disorders
   Logan, UT 84322-1000
3. Sponsor U.S. Dept. of Education
4. Name of research The Efficacy of Transient Evoked Otoacoustic Emissions in Identifying Hearing Loss in Children with Developmental Disabilitie
5. Purpose Identification of hearing loss in young children with existing disabilities
6. Departments Communicative Disorders, Psychology
7. Curriculum areas Special Education, Regular Education
8. Grades to be involved (4th, 5th, etc.) Preschool through 2nd Grade
9. Number of students included 100 non-disabled (Regular Education), All children with disabilities
10. Total school time required MINIMAL; Research to be coordinated in conjunction with existing hearing screening program
11. School personnel involved Steve Jensen, Audiologist

12. General statement or over-view of research (may attach separate sheet if needed)

See attached sheet

13. Attach any questionnaires or information sent to students or parents with this form.

See attached parent/guardian consent letter and information form .

Approved _____ Approval subject to modification _____ Rejected _____

_____
Signature, Committee Chairperson

12. Research suggests that a substantial percentage (estimates range between 32% and 78%) of children with developmental disabilities in the United States have a mild to profound hearing loss. Many of these children remain undiagnosed for years because they are difficult to test using the traditional audiometric procedures. The value of educational and therapeutic programs for children with disabilities and a concomitant hearing loss is severely impaired if the hearing impairment is not correctly identified and treated.

The goals of the project are to (a) identify hearing loss in children with already confirmed disabilities using traditional audiometric screening and assessment procedures combined with technology developed in the last few years consisting of Transient Evoked Otoacoustic Emissions testing (TEOAE); and (b) compare the sensitivity and specificity of traditional screening programs with TEOAE testing programs in a group of normal children and a group of children who have been identified as having one or more disability. The TEOAE testing procedure allows for a quick, non-invasive test of cochlear function without assistance from the person who is being evaluated. Such a device, should it prove both cost-efficient and reliable, would allow for early detection of hearing loss in children with developmental disabilities, thereby providing for them a more optimal learning future.

During the first year of the three-year project Steve Jensen, District Audiologist, and the project audiologists will collect audiological data from a total 250 students with disabilities. At least 50 children in this group will be 3 to 5 years of age; the remainder will be 5 to 7 years old. Prior to initiating the data collection phase of the project, test protocols will be reviewed and scoring protocols will be developed.

Audiological equipment not used in school (e.g., otoscopes) will be donated to the school district's hearing screening program at the completion of the project. Follow-up testing for children on whom data audiological data cannot be gathered in the school setting will be provided free of charge to the school district and parents/guardians by the Utah State University Speech-Language-Hearing Center. A record of the final hearing status of each child screened and/or followed up will be provided to Steven Jensen for placement in appropriate school district files.

LOGAN CITY SCHOOLS

GUIDELINES - RESEARCH COMMITTEE

1. Procedure:

   a. Secure application form from the chairman of the Research Committee.
   b. Complete application form and return to committee chairman.
   c. Copies of the proposal will be sent to committee members for study one week in advance of a committee meeting.
   d. Action on proposals will be taken by the committee in a meeting called by the chairman.
   e. Action taken by the committee will be reported to the person making the proposal by the committee chairman.

2. Research that makes a contribution to the district or the field of education will be considered.

3. The use of school time, number of students involved and number of school personnel should be held to a minimum.

4. Copies of research results will be filed with the district upon completion. Also, the results will be made available to school personnel.

5. After approval is given, the person or persons doing research must be held responsible for activities conducted, forms used and conclusions made.

6. Research should not be done during the first month or the last month of the school year.

7. Where student names are used, the names should be given identifying numbers and all individual information held confidential.

8. Costs for doing research in the district must be assumed by the person or persons doing the research.

9. Letters and information sent to parents must first be approved by school principals, and the research committee.

STATEMENT OF PI TO THE IRB FOR PROPOSED
RESEARCH INVOLVING HUMAN SUBJECTS

Proposal Title The Efficacy of Transient Evoked Otoacoustic Emissions in Identifying Hearing Loss in Children with Developmental Disabilities

Primary Researcher Brandt Culpepper, Ph.D./Karl White, Ph.D. Dept. Comm Dis Ext. 1378

Student Researcher* _____ Dept. _____ Ext. ____

A. In this research human subjects will perform the following activities: Subjects will be screened according to existing audiological protocols in school districts and will receive additional services of otoscopy, tympanometry, and TEOAEs. Pure-tone thresholds will be obtained for each child and follow-up referrals will be made as deemed necessary.

B. The potential benefits to be gained from the proposed research are: Improved audiological services will be established for children in participating local school districts and throughout educational systems nationally.

C. The risk(s) to the rights and welfare of human subjects involved are: None.

D. The following safeguards/measures to mitigate/minimize the identified risks will be taken: No names will be recorded on data sheets. Follow-up referral letters for services outside of the project will be kept separately and will be tracked by educational audiologists.

E. The Informed Consent procedures for subjects will be as follows: (Explain procedures to be followed and attach an example of the informed consent instrument):
Participation by the primary caregivers will be voluntary (see attached parent/guardian informed consent letter and information form).

F. The following measures regarding confidentiality of subjects will be taken: Data will be collected without any identifying information from subjects and numerically coded in a secured electronic data file.

G. Other (If, in your opinion no, or minimal, risk to subjects exists, please explain in this section): None.

Brandt Culpepper
PI Signature

Student Researcher* Signature

*If Applicable

TEOAE Hearing Screening Project

PARENT INFORMATION QUESTIONNAIRE

This sheet is two-sided. Please provide us with the following information to the best of your knowledge on both sides of this sheet. In our records, this information will only be accessible by an identification number to which no names will be linked.

Child's Name: _____ **Grade:** _____ **Date of Birth:** ___/___/___

Child's Gender (circle): Male Female

Developmental Information

At birth or soon after (1 month), did your child have any of the following (check all that apply and circle when applicable)?

___ **Family history of childhood hearing loss**
___ **Maternal infection such as (please circle all that apply):**

Cytomegalovirus (CMV) *Rubella* *Toxoplasmosis* *Syphilis*

___ **Malformations of the face or outer ear or ear canal**
___ **Birth weight less than 3 lbs., 5 oz.**
___ **Jaundice which required a transfusion**
___ **Bacterial meningitis**

After 1 month of age until present (check all that apply):

___ **Do you or other caregivers have concern about your child's hearing, speech, or language?**
___ **Has your child sustained a head trauma involving loss of consciousness or skull fracture?**
___ **Has your child had any of the following childhood diseases (circle all that apply)?**

Bacterial Meningitis *Mumps* *Chicken Pox* *Cytomegalovirus (CMV)*

Previous Hearing Test Information

Has your child had his or her hearing tested before? ___ Yes ___ No

Were you informed that your child had a hearing problem? ___ Yes ___ No

If the results of the hearing testing indicated that your child had a hearing problem, what were the recommendations, if any, of the person who tested your child's hearing?

_____

_____

**** Please Turn This Sheet Over ****

Date: __/__/__

Dear Parent/Guardian:

In a few days, your child will be bringing home a letter and parent consent form. The letter will request your participation in a hearing screening project conducted by the Department of Communicative Disorders at Utah State University as part of the regular hearing screening program offered by the Cache School District.

Participation of your child in the hearing screening project is voluntary and there are no risks to your child. However, the project could provide valuable information about your child's hearing. Additionally, if you were to have to pay for these services, the cost would be approximately $75.00. When you receive the letter and consent form, please consider participating. Thank you for your time and consideration.

Sincerely,

Steven Jensen
District Audiologist

Brandt Culpepper
USU Audiologist

UTAH STATE UNIVERSITY · LOGAN, UTAH 84322-1000

DEPARTMENT OF COMMUNICATIVE DISORDERS
Speech-Language-Hearing Center
(801) 750-1375

Date: __/__/__

Dear Parent/Guardian of _____,

As a part of the regular hearing screening program offered by the Cache School District, the Department of Communicative Disorders at Utah State University would like your permission to administer a new hearing test to your child as part of a project sponsored by the U.S. Department of Education. The project will be comparing two types of tests used to screen the hearing of children in schools to determine which test is better for the school hearing screening program. In addition to the hearing tests regularly administered to students, we would like to administer a test called transient evoked otoacoustic emissions (TEOAE). The TEOAE test involves placement of a small earphone into each of your child's ears and presenting a series of clicks. These clicks are received back from your child's inner ear through a small microphone contained within the earphone and relayed to a portable computer. The TEOAE test can provide the school audiologist with important additional information about your child's hearing.

Participation of your child in this hearing screening project is voluntary and there are no risks to your child. If you agree to have your child's hearing screened using the TEOAE procedure, please sign the enclosed consent form and return it with a completed "Parent Information Questionnaire" (also attached) in the self-addressed, postage-paid envelope provided. If you have any questions about this research, please call Mr. Steve Jensen, District Audiologist at 753-2100. Thank you for your time and consideration, and we hope you will agree to participate in this project.

Sincerely,

Steven Jensen
District Audiologist

Brandt Culpepper
USU Audiologist

Enclosures

Professional Education Programs in Speech-Language Pathology and Audiology
accredited by the Educational Standards Board of the American Speech-Language-Hearing Association

TEOAE Hearing Screening Project

PARENT/GUARDIAN CONSENT FORM

I agree to have my child, _____,
(child's name)
receive testing using transient evoked otoacoustic emissions (TEOAE) as part of the regular hearing screening program offered by the Cache School District.

_____ ___/___/___
Parent/Guardian Signature Date

Project ID#: _____

Date: ___/___/___

Dear Parent/Guardian:

In a few days, your child will be bringing home a letter and parent consent form. The letter will request your participation in a hearing screening project conducted by the Department of Communicative Disorders at Utah State University as part of the regular hearing screening program offered by the Cache School District.

Participation of your child in the hearing screening project is voluntary and there are no risks to your child. However, the project could provide valuable information about your child's hearing. Additionally, if you were to have to pay for these services, the cost would be approximately $75.00. When you receive the letter and consent form, please consider participating. Thank you for your time and consideration.

Sincerely,

Steven Jensen
District Audiologist

Brandt Culpepper
USU Audiologist

Date: ___/___/___

Dear Parent/Guardian of _____,

As a part of the regular hearing screening program offered by the Cache School District, the Department of Communicative Disorders at Utah State University would like your permission to administer a new hearing test to your child as part of a project sponsored by the U.S. Department of Education. The project will be comparing two types of tests used to screen the hearing of children in schools to determine which test is better for the school hearing screening program. In addition to the hearing tests regularly administered to students, we would like to administer a test called transient evoked otoacoustic emissions (TEOAE). The TEOAE test involves placement of a small earphone into each of your child's ears and presenting a series of clicks. These clicks are received back from your child's inner ear through a small microphone contained within the earphone and relayed to a portable computer. The TEOAE test can provide the school audiologist with important additional information about your child's hearing.

Participation of your child in this hear...g screening project is voluntary and there are no risks to your child. If you agree to have your child's hearing screened using the TEOAE procedure, please sign the enclosed consent form and return it with a completed "Parent Information Questionnaire" (also attached) in the self-addressed, postage-paid envelope provided. If you have any questions about this research, please call Mr. Steve Jensen, District Audiologist at 753-2100. Thank you for your time and consideration, and we hope you will agree to participate in this project.

Sincerely,

Steven Jensen District Audiologist	Brandt Culpepper USU Audiologist

Enclosures

TEOAE Hearing Screening Project

PARENT/GUARDIAN CONSENT FORM

I agree to have my child, _____,
(child's name)
receive testing using transient evoked otoacoustic emissions (TEOAE) as part of the regular hearing screening program offered by the Cache School District.

_____ ___/___/___
Parent/Guardian Signature **Date**

Project ID#: _____

Date: ___/___/___

Dear Parent/Guardian:

In a few days, your child will be bringing home a letter and parent consent form. The letter will request your participation in a hearing screening project conducted by the Department of Communicative Disorders at Utah State University as part of the regular hearing screening program offered by the Logan School District.

Participation of your child in the hearing screening project is voluntary and there are no risks to your child. However, the project could provide valuable information about your child's hearing. Additionally, if you were to have to pay for these services, the cost would be approximately $75.00. When you receive the letter and consent form, please consider participating. Thank you for your time and consideration.

Sincerely,

Steven Jensen
District Audiologist

Brandt Culpepper
USU Audiologist

UTAH STATE UNIVERSITY · LOGAN, UTAH 84322-1000

DEPARTMENT OF COMMUNICATIVE DISORDERS
Speech-Language-Hearing Center
(801) 750-1375

August 25, 1993

Dr. Debra Cheney
Director of Special Services
Logan City School District
101 West Center Street
Logan, UT 84321-4563

Dear Dr. Cheney:

In November 1992, we submitted a field-initiated research grant proposal entitled **The Efficacy of Transient Evoked Otoacoustic Emissions in Identifying Hearing Loss in Children with Developmental Disabilities** to the U.S. Department of Education, Office of Special Education and Rehabilitative Services. In June 1993, we learned that this three-year project (Award #: HO 23C 30039) had been funded with a start date of September 1, 1993.

The proposal was submitted because research suggests that a substantial percentage (estimates range between 32% and 78%) of children with developmental disabilities in the United States have a mild to profound hearing loss. Many of these children remain undiagnosed for years because they are difficult to test using the traditional audiometric procedures. The value of educational and therapeutic programs for children with disabilities and a concomitant hearing loss is severely impaired if the hearing impairment is not correctly identified and treated.

The goals of the project are to (a) identify hearing loss in children with already confirmed disabilities using traditional pure tone audiometric screening and assessment procedures combined with technology developed in the last few years consisting of Transient Evoked Otoacoustic Emissions testing (TEOAE); and (b) compare the sensitivity and specificity of traditional pure tone screening programs with TEOAE testing programs in a group of normal children and a group of children who have been identified as having one or more disability. The TEOAE testing procedure allows for a quick, non-invasive test of cochlear function without assistance from the person who is being evaluated. Such a device, should it prove both cost-efficient and reliable, would allow for early detection of hearing loss in children with developmental disabilities, thereby providing for them a more optimal learning future.

Professional Education Programs in Speech-Language Pathology and Audiology
accredited by the Educational Standards Board of the American Speech-Language-Hearing Association

During the first year of the three-year project we will collect audiological data from a total 250 students with disabilities. At least 50 children in this group will be 3 to 5 years of age; the remainder will be 5 to 7 years old. Prior to initiating the data collection phase of the project, test protocols will be reviewed and scoring protocols will be developed.

We have been in touch with Steve Jensen from your school district and he has expressed interest in participating in this project. All efforts will be made to coordinate with the existing screening schedule when possible. All necessary human subject and proposed research forms have been submitted for approval. We would like your support in this endeavor and will be contacting you soon regarding the necessary procedures for proceeding with this project in your school district.

We would also like you to be aware of the service that will be provided to your school district. All behavioral testing necessary to determine the hearing status of each child participating will be offered to the school district and to the parents of the child free of charge. For test results which cannot be obtained in the school setting, children will be referred to the Speech-Language-Hearing Center at Utah State University. In addition, the advanced instrumentation which will be used in the school district (such as magnifying otoscopes and ultrasonic cleaners) will be donated to the school audiologist. Above all, we will attempt to be as unobtrusive as possible and will take every effort to avoid disrupting ongoing classroom activities.

If you have any questions or need clarification on the proposed project, please do not hesitate to contact me. Thank you!

Brandt Culpepper, Ph.D., CCC-A
Assistant Professor/Project Co-Director
Dept. of Communicative Disorders
Utah State University
Logan, UT 84322-1000
(801)750-1378

Gary W. Mauk, M.A., CAGS
Project Coordinator
Dept.of Psychology
Utah State University
Logan, UT 84322-2810
(801)750-1182

cc: Steve Jensen, Audiologist

LOGAN CITY SCHOOL DISTRICT

101 WEST CENTER LOGAN, UTAH 84321-4563
PHONE 801-755-2300
FAX NUMBER 801-755-2311

INISTRATION
Larry Petersen,
ing Superintendent
Jensen,
siness Administrator
ora Cheney,
ecial Services Director
chard J. Jensen,
rriculum Director
Lynch,
rsonnel Director
Davidson,
od Service &
ult Ed. Supervisor

November 10, 1992

Karl White, Ph.D.
Department of Psychology
Utah State University
Logan, Utah, 84322-2810

Dear Dr. White:

I was most interested to review your proposal to screen school-aged children with disabilities using evoked otoacoustic emissions equipment and procedures. The students in Logan School District would benefit from cooperating in a field test of this nature.

Please accept our support in pursuing this project.

Sincerely,

Debra Cheney

Debra Cheney, Ph.D.
Director, Special Services

ch

BEST COPY AVAILABLE

PROVO CITY SCHOOL DISTRICT

Superintendent
KAY W. LAURSEN

SPECIAL PROGRAMS
TED KELLY, Coordinator
PAMELA COLSON, Specialist
NANCY JONES, Specialist

January 5, 1994

Brandt Culpepper, Ph.D., CCC-A
Dept. of Communicative Disorders
Utah State University
Logan, UT 84322-1000

Dear Brandt,

Please excuse my taking so long to get back to you in writing, but I need to let you know that I have obtained permission to work together on the TEOAE project described in your letter dated September 29, 1993. As you know, I have also discussed this project with Sara Tidwell, and I indicated to her that we will need to meet sometime in late July or early August of this year in order to finalize the necessary on-site details prior to beginning data collection. My supervisor, Mr. Ted Kelly, Coordinator of Special Programs, has given his approval and support of our combined efforts regarding this project.

I believe that the use of TEOAE testing in the public school setting has great potential and I feel certain that we will eventually use this technology in Provo School District. This project will enable us to examine the utilization and application of TEOAE procedures in the public schools as well as to provide your project with information that will ultimately benefit many professionals and children nationwide.

I am anxiously excited and looking forward to working together later this year. Please call me at 374-4895 if we need to confer prior to that time.

Very Sincerely,

Kim Hepworth

Kim Hepworth, M.C.D., CCC-A
District Audiologist

KH/kh

280 W. 940 N. ● PROVO, UTAH 84604-3394 ● (801) 374-4933 ● FAX (801) 374-4808

Utah State UNIVERSITY

DEPARTMENT OF COMMUNICATIVE DISORDERS
AND DEAF EDUCATION
Speech-Language-Hearing Center
Logan, Utah 84322-1000
V/TTY: (801) 797-1375
FAX: (801) 797-0221

Date: 9/30/94

Dear Parent/Guardian:

As a part of a project being conducted in Provo School District, the Department of Communicative Disorders at Utah State University would like your permission to screen your child's hearing using traditional tests and a new screening procedure that uses a computer. The project will be comparing two types of tests used to screen the hearing of children in schools to determine which test is better for a school hearing screening program. These tests will also provide the school audiologist with important information about your child's hearing.

Participation of your child in this hearing screening project is voluntary and there are no risks to your child. If your child is between ages 3 and 7, and you agree to have your child's hearing screened, please sign the enclosed consent form and return it with a completed "Parent Information Questionnaire" in the self-addressed, postage-paid envelope provided. The test results and information you provide will help us determine if the new test is beneficial for all children in addition to providing information to the district about your child's hearing.

If you have any questions about this project, please contact Kim Hepworth at 374-4895. Thank you for your time and consideration, and we hope you will agree to have your child participate in this project.

Please return the Consent Form and Parent Information Questionnaire by 10/16/94 **in the envelope provided.**

Sincerely,

Kim Hepworth
Kim Hepworth
District Audiologist

Brandt Culpepper
Brandt Culpepper
USU Audiologist

Enclosures

American Speech-Language Hearing Association
Educational Standards Board
• Accredited •
Speech-Language Pathology / Audiology

Program in Education of the Deaf and the Hard of Hearing accredited by the Council on Education of the Deaf

DAVID L. WEST, SUPERINTENDENT

March 24, 1994

Brandt Culpepper, Ph.D.
Department of Communications DDE
Utah State University
Logan, Utah 843222-1000

Dear Dr. Culpepper:

It has been brought to my attention that you are needing students to participate in a study project. It is a study using transient evoked otacoustic emissions (TEOAEO) to screen for hearing loss. I have several severely multiply handicapped (SMH) preschool children that I would like to have screened by this method.

I understand that this testing may help provide some further information for our school audiologist since SMH students are sometimes difficult to test with the conventional methods. If you feel, it would benefit your project and my students to be involved in the testing I hereby give my approval for the screening. Thank you for the opportunity to participate in this learning endeavor.

Respectfully yours,

Melanie S. Wood

Melanie S. Wood
USB Program Director

;msw

EXTENSION OFFICE
2870 CONNOR STREET / SALT LAKE CITY, UTAH 84109 / (801) 487-8105 / TTY & VOICE

WEBER COUNTY SCHOOL DISTRICT

SUMMARY OF PROPOSED RESEARCH PROJECT

(To be completed by investigator(s) seeking district's participation in research)

Request to conduct research in cooperation with Weber County School District

This form will assist the district in reviewing the research request, recognizing the value of good research for the future of the student, and the immediate educational responsibilities of the schools. The researcher is asked to complete this form and furnish other information requested as promptly as possible to allow the district to make an informed and early decision. If more space is required, please attach pages with reference to item number.

A. Source of Request

1. Principal investigator(s) Brandt Culpepper, Ph.D. ,Karl R.White, Ph.D

2. Project title The Efficacy of Transient Evoked Otoacoustic Emissions in Identifying Hearing Loss in Children with Developmental Disabilities

3. Person making request Brandt Culpepper, Ph.D.

   Position (if student, so indicate) Assistant Professor

   Address Department of Communicative Disorders

   Utah State University, Logan, UT 84322-1000

   Telephone 801/797-1378

4. This project is: (Check and complete all that apply)

   (a) X faculty/staff research sponsored at

   Utah State University
   (Name of institution or agency)

   (b) ____ research conducted in partial fulfillment of requirements for a course or degree

   Department _____

   Institution _____

   Candidate for following degree _____

Name of research advisor/supervisor _____

Title or Position _____

(c) ____ other (please describe) _____

_____

_____

5. Support for project: (check one)

____ supported primarily by institution or agency making the request

____ personal funds of the investigator(s)

__X__ grant or contract from another agency

Name of agency U.S. Department of Education

____ has been/will be submitted to another agency for review and possible funding

Name of agency _____

B. General Project Description

6. Purpose(s) of the research. See attached sheet.

_____

_____

_____

7. Outline of procedures (number of schools, total population to be involved, treatment, data to be gathered, etc.)

See attached sheet.

_____

_____

_____

_____

8. Date the investigator plans to initiate project in the district.

April 1995

9. Description of student/subjects from this district, if applicable (e.g., number, ages, academic level, etc.)

See attached sheet.

10. Description of information required from district records or personnel, if applicable.

Parents' addresses for mailing permission forms

11. Description of specific procedures actively involving students, graduates, parents, or staff of this district. (If tests, questionnaires, interview protocols, etc. are to be used, please furnish copies.)

See #7 on attached sheet. Parents/ guardian consent letter and information forms are also attached.

12. Estimate of total time requirement for each subject. Minimal

13. Estimate of total time requirement for all district staff. None

C. Benefits and Risks

14. Indicate any benefits likely to result from this research for students, staff, and/or parents of this district.

Young children with existing developmental disabilities may have previously undetected hearing losses identified. As a result, these children can be referred for appropriate audiological management.

152

15. What risks, if any, would this research involve for participants from this district? If risks are present, indicate the justification for the procedures and steps to be taken to minimize risk.

None

16. (a) Does the sponsoring institution have an Institutional Review Board (IRB) for the protection of human subjects which complies with federal regulations?

X yes _____ no

(b) If "yes" (check one)

X This project has been approved by the IRB (attach copy of IRB's decision and any conditions; also attach copy of approved informed consent form if applicable).

_____ Plans are to submit this project to the IRB before initiating the project in the school. The school will be furnished with evidence of approval before the research is initiated.

D. Agreement

In the event the project is approved for conduct in the district, the investigator(s) agree to the following conditions:

1. To adhere to the purpose and procedures of the project as approved by the district and to restrict the use of data gathered in cooperation with the district to this project.

2. To furnish the district with progress reports on request.

3. To provide the district with one copy of all publications, including dissertations, reports, articles, and papers, describing the completed project.

4. To acknowledge the cooperation of the district in any published report of the project.

5. To give permission for the district to cite the ongoing or completed project in its own publications, with credit to the investigator(s).

Further, the investigator(s) agrees to the following:

1. To comply with the Family Educational Rights and Privacy Act and amendments thereto.

2. To comply with federal regulations for the protection of human subjects.

3. To report only group data, and no information which can be traced directly or by inference to a specific student, family members of the student, or former school attended.

4. If student identification by name, social security number, or other means is necessary for bringing data together on a specific student, to remove this identification as soon as the data have been assembled, and under no condition permit this identification to be shared with other parties.

5. To destroy all materials gathered which contain personally identifiable information after the purposes for which the material was gathered have been completed.

Copies of the following should also be forwarded to the district:
- a more detailed description of the project
- copy of test, questionnaire, interview protocol, etc. to be used in cooperation with the district
- if applicable, IRB approval and approved informed consent form
- the vita of the principal investigator(s) would also assist in the district's review process

Brent L. White

Investigators' signatures

If student research, signature of research advisor/supervisor

District Research Specialist

Date 20 March 1995

Appendix B: Data Collection Schedules, Contact Persons, and Participating Schools

Tentative TEOAE Schedule for Spring Quarter 1994

Date	School	City	Contact
April 12 (T)	North Park	Tremonton	LaVar Douglas 257-5762
April 18, 19 (M,T)	Mt. View	Brigham City	Earl Swenson 723-8686
April 25 (M)	Lincoln	Brigham City	Wade Hyde 723-3365
May 2 (M)	McKinley	Tremonton	Don Shakespeare 257-3413
May 3 (T)	Bear River City	Bear River City	Mary Kay Kirkland 279-8644
May 9 (M)	Central	Brigham City	Marilyn Anderson 723-2884
May 10 (T)	North Park	Tremonton	
May 16 (M)	Foothill	Brigham City	Joan Stokes 723-7832
May 17 (Meet with Terry Clawson of Davis Schools)			
May 18			
May 23, 24 (M,T)	USDB	SLC	Kathy, Christine 487-8105

TENTATIVE SCHEDULE FOR TEOAE GRANT 1994-1995

Month	School District	# of Students	Contact	Approval
August	Davis	57,116	Terry Clawson 451-1040	Verbal
Sept	Provo	13,565	Kim Hepworth	Letter
Oct-Dec	Jordon	68,800	Sue Hutchins 565-7195	Applied
Jan-Feb	Weber	26,800	Alice Kirk 476-7800	
Mar-May	Alpine	40,322	Tim Humphries 785-8737 Richard Mecham 756-8458	Interested; need to contact res.

TEOAE Schedule for Spring Quarter 1994

Date	School	City	Contact
April 12 (T)	North Park	Tremonton	LaVar Douglas 257-5762
April 18, 19 (M,T)	Mt. View	Brigham City	Earl Swenson 723-8686
April 25 (M)	Lincoln	Brigham City	Wade Hyde 723-3365
May 2 (M)	McKinley	Tremonton	Don Shakespeare 257-3413
May 3 (T)	Bear River City	Bear River City	Mary Kay Kirkland 279-8644
May 9 (M)	Central	Brigham City	Marilyn Anderson 723-2884
May 10 (T)	North Park	Tremonton	(see above)
May 16 (M)	Mt. View	Brigham City	(see above)
May 17 (T)	(Meet with Terry Clawson of Davis Schools) 451-1040		
May 18 (W)	Foothill	Brigham City	Joan Stokes 723-7832
May 23, 24 (M,T)	USDB	SLC	Kathy, Christine 487-8105

TENTATIVE SCHEDULE FOR TEOAE GRANT 1994-1995

Month	School District	# of Students	Contact	Approval
August	Davis	57,116	Terry Clawson 451-1040	Meeting May 17
Sept	Provo	13,565	Kim Hepworth	Letter
Oct-Dec	Jordon	68,800	Sue Hutchins 565-7195	Approved
Jan-Feb	Weber	26,800	Alice Kirk 732-6006	Interested; She will contact Sp. Ed Director
Mar-May	Alpine	40,322	Tim Humphries 785-8737 Richard Mecham 756-8458 Frank Cameron- over research	Need to complete application

Box Elder
Barbra Bryner, SLP, Chairman, Speech Dept
Lakeview Elementary
851 S 200 W, Brigham City 84302
723-1283 (723-8975 School)

Box Elder
Jerry Jones
Corrine School
2275 N 3900 West, Corrine 84307
744-2468

Box Elder
Kirk Allen, Coordinator of Special Education
230 West 200 South
Brigham city, UT 84302
723-5281

Cache
Julie Landeen, Director of Special Education
2063 North 1200 East
North Logan, Ut 84321
752-3925

Cache/Logan
Steve Jensen, Audiologist
Cache Testing Center
495 E 500 South, River Heights
753-2100 / 750-9141 (dial twice for beeper)

Davis School District
Terry Clawson, Audiologist
Monte Vista Diagnostic Center
70 S 200 E, Farmington, UT 84050
451-1040

Granite
Judy Farmer, Coordinator of Hearing Services
Student Support Services
3031 S 200 E, SLC. UT 84115
481-7111

Logan
Debra Cheney, Director of Special Services
101 West Center
Logan, UT 84321-4565
755-2300

Provo
Kim Hepworth, Audiologist
280 West 940 North
Provo, UT 84604
373-6301

REFERRAL ADDRESSES

PHYSICIANS

Gary R. Gibbons, M.D.
1300 North 500 East, Suite 240
Logan, UT 84321

Douglas Hart, M.D.
150 East 200 North
Logan, UT 84321

Roger J. Simpson, M.D.
225 East 400 North
Logan, UT 84321

Gordon Wood, M.D.
1300 North 500 East, Suite 240
Logan, UT 84321

CLINICS

Budge Clinic
225 East 400 North
Logan, UT 84321

Logan Regional Hospital
Speech-Language Pathology and Audiology
1400 North 500 East
Logan, UT 84321

Logan Hearing Center
129 East 1400 North
Logan, UT 84321

Primary Children's Medical Center
100 North Medical Drive
Salt Lake City, UT 84113-1100

AGENCIES

Division of Vocational Rehabilitation
180 North 100 East
Logan, UT 84321

Bureau of Communicative Disorders
Regional State Office Building
2540 Washington Blvd.
Ogden, UT 84401

State Health Department
Bureau of Communicative Disorders
44 Medical Drive
Salt Lake City, UT 84114

Cache County Schools Testing Center
420 South 500 East
Logan, UT 84321

SKI*HI INSTITUTE
UMC 9605

Headstart/Homestart
75 South 400 West
Logan, UT 84321

UTAH SCHOOL FOR THE DEAF
742 Harrison Blvd.
Ogden, UT 84404

Edith Bowen Laboratory School
UMC 6700

Center for Persons with Disabilities
UMC 6800

SCHOOLS

Adams School
530 North 400 East
Logan, UT 84321

Ellis School
348 West 300 North
Logan, UT 84321

Lewiston Elementary
107 East 200 South
Lewiston, UT 84320

Logan High School
162 West 100 South
Logan, UT 84321

Mountain Crest High School
255 South 800 East
Hyrum, UT 84319

Park Elementary
90 South 100 West
Richmond, UT 84333

River Heights Elementary
1075 Sumac Drive
Logan, UT 84321

Summit Elementary
80 West Center
Smithfield, UT 84335

Wilson Elementary
89 South 500 East
Logan, UT 84321

Cedar Ridge Middle School
65 North 200 West
Hyde Park, UT 84318

South Cache Middle School
29 North 400 West
Hyrum, UT 84319

Mount Logan Middle School
875 North 200 East
Logan, UT 84321

Hillcrest Elementary
960 North 1400 East
Logan, UT 84321

Lincoln Elementary
62 West 100 South
Hyrum, UT 84319

Millville Elementary
67 South Main
Millville, UT 84326

North Park Elementary
2800 North 800 East
Logan, UT 84321

Providence Elementary
91 East Center
Providence, UT 84332

Sky View High School
520 South 250 East
Smithfield, UT 84335

Wellsville Elementary
90 East 100 South
Wellsville, UT 84339

Woodruff Elementary
650 South 1000 West
Logan, UT 84321

North Cache Middle School
571 South 200 West
Richmond, UT 84333

Spring Creek Middle School
350 West 100 North
Providence, UT 84332

Appendix C: Data Collection, Encoding, and Summary Sheets

TEOAE Screening for Hearing Loss in Schools

Fall, 1993

Date	Dist/School	# Sent	Consent	Tested	w/o DD	w/DD
Totals						

TEOAE Screening for Hearing Loss in Schools

Winter, 1994

Date	Dist/School	# Sent	Consent	Tested	Pass	Fail
Totals						

TEOAE Hearing Screening Project

PARENT INFORMATION QUESTIONNAIRE

This sheet is two-sided. Please provide us with the following information to the best of your knowledge on both sides of this sheet. In our records, this information will only be accessible by an identification number to which no names will be linked.

Child's Name: _____ **Grade:** _____ **A.M. P.M.**

Date of Birth: ___/___/___ **Teacher:** _____

Child's Gender (circle): Male Female **School:** _____

Developmental Information

At birth or soon after (1 month), did your child have any of the following (check all that apply and circle when applicable)?

___ **Family history of childhood hearing loss**
___ **Maternal infection such as (please circle all that apply):**

Cytomegalovirus (CMV) *Rubella* *Toxoplasmosis* *Syphilis*

___ **Malformations of the face or outer ear or ear canal**
___ **Birth weight less than 3 lbs., 5 oz.**
___ **Jaundice which required a transfusion**
___ **Bacterial meningitis**

After 1 month of age until present (check all that apply):

___ **Do you or other caregivers have concern about your child's hearing, speech, or language?**
___ **Has your child sustained a head trauma involving loss of consciousness or skull fracture?**
___ **Has your child had any of the following childhood diseases (circle all that apply)?**

Bacterial Meningitis *Mumps* *Chicken Pox* *Cytomegalovirus (CMV)*

Previous Hearing Test Information

Has your child had his or her hearing tested before? ___ Yes ___ No

Were you informed that your child had a hearing problem? ___ Yes ___ No

If the results of the hearing testing indicated that your child had a hearing problem, what were the recommendations, if any, of the person who tested your child's hearing?

_____

_____

****** Please Turn This Sheet Over ******

TEOAE Hearing Screening Project

PARENT INFORMATION QUESTIONNAIRE
(continued)

Ear Infection Information

Is your child prone to frequent ear infections? ___ Yes ___ No

If "Yes," about how many ear infections does your child have per year? _____

When was the last ear infection? _____

How have the infections been treated? _____

_____

In which ear(s) has your child had ear infections?

_____ Right Ear _____ Left Ear _____ Both Ears

Has or does your child have PE tubes in his or her ear(s)? ___ Yes ___ No

If "Yes," please check the ear(s) in which your child has had or has PE tubes:

_____ Right Ear _____ Left Ear _____ Both Ears

COMMENTS

_____

_____

_____

_____

Thank You For Participating!

Project ID#: _____

SCREENING COVER SHEET

Name: _____

Subject ID ☐☐☐☐☐☐☐

Grade _____ ☐

Age _____ ☐☐

Date of Birth ___/___/___ ☐☐☐☐☐☐
yr yr m m d d

School _____ ☐☐

Category of Disability _____ ☐☐

Previously Identified HL _____ ☐

Nature _____ ☐

Degree _____ ☐

STUDENT DEMOGRAPHIC DATA FORM

☐ Card Number

☐☐☐☐☐☐☐ Subject ID

Key:
1-present
2-absent
3-do not know

Grade ☐

Date of Birth ☐☐☐☐☐☐ (yr yr m m d d)

Category of Disability ☐☐

Gender ☐

Family History ☐

CMV ☐

Rubella ☐

Toxoplasmosis ☐

Syphilis ☐

Malformation ☐

Birth Weight ☐

Jaundice ☐

Bacterial Meningitis ☐

Concern ☐

Head Trauma ☐

Mumps ☐

Chicken Pox ☐

CMV ☐

Hearing Testing ☐

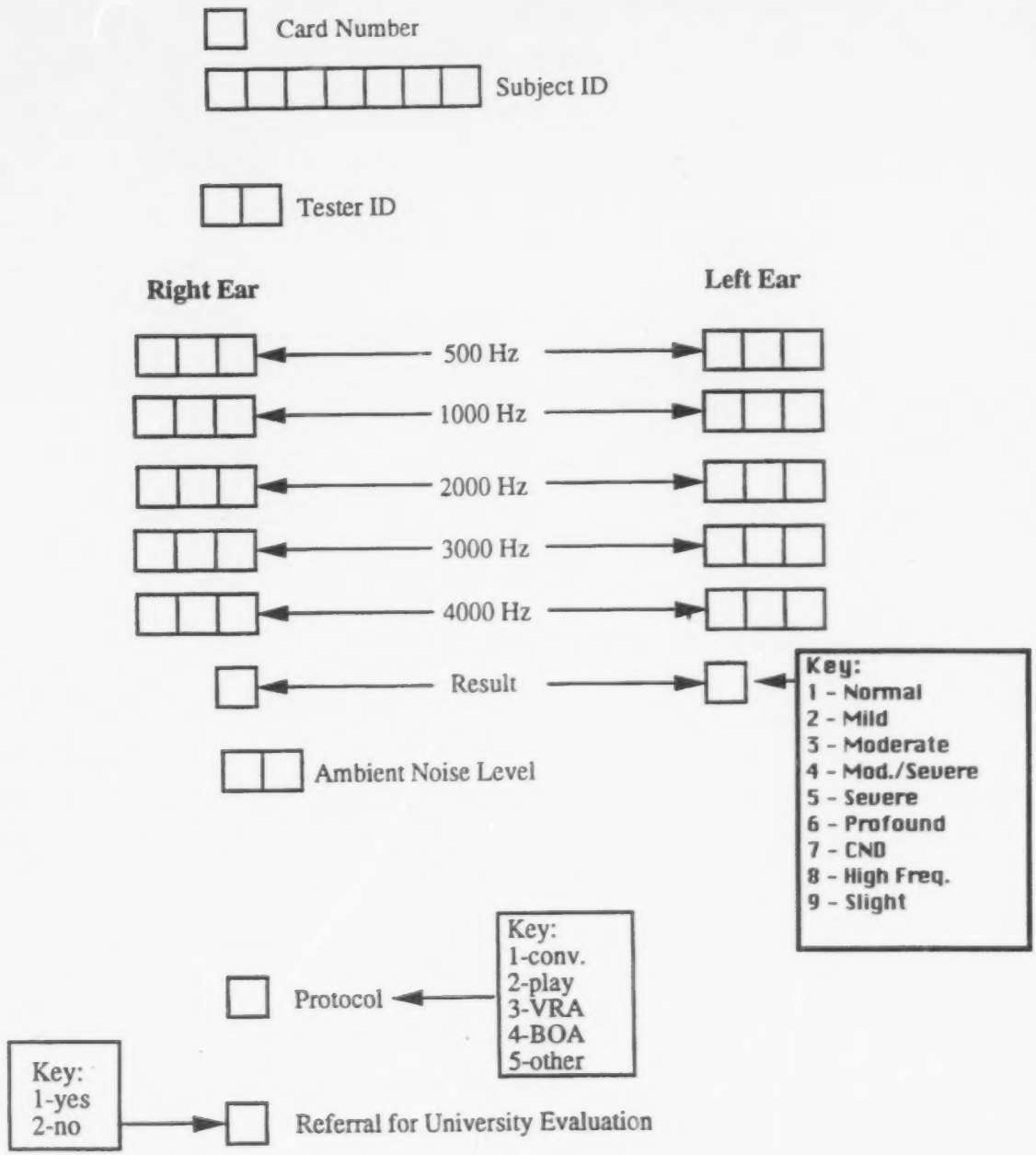
Hearing Problem ☐

Ear Infection ☐

PE Tubes ☐

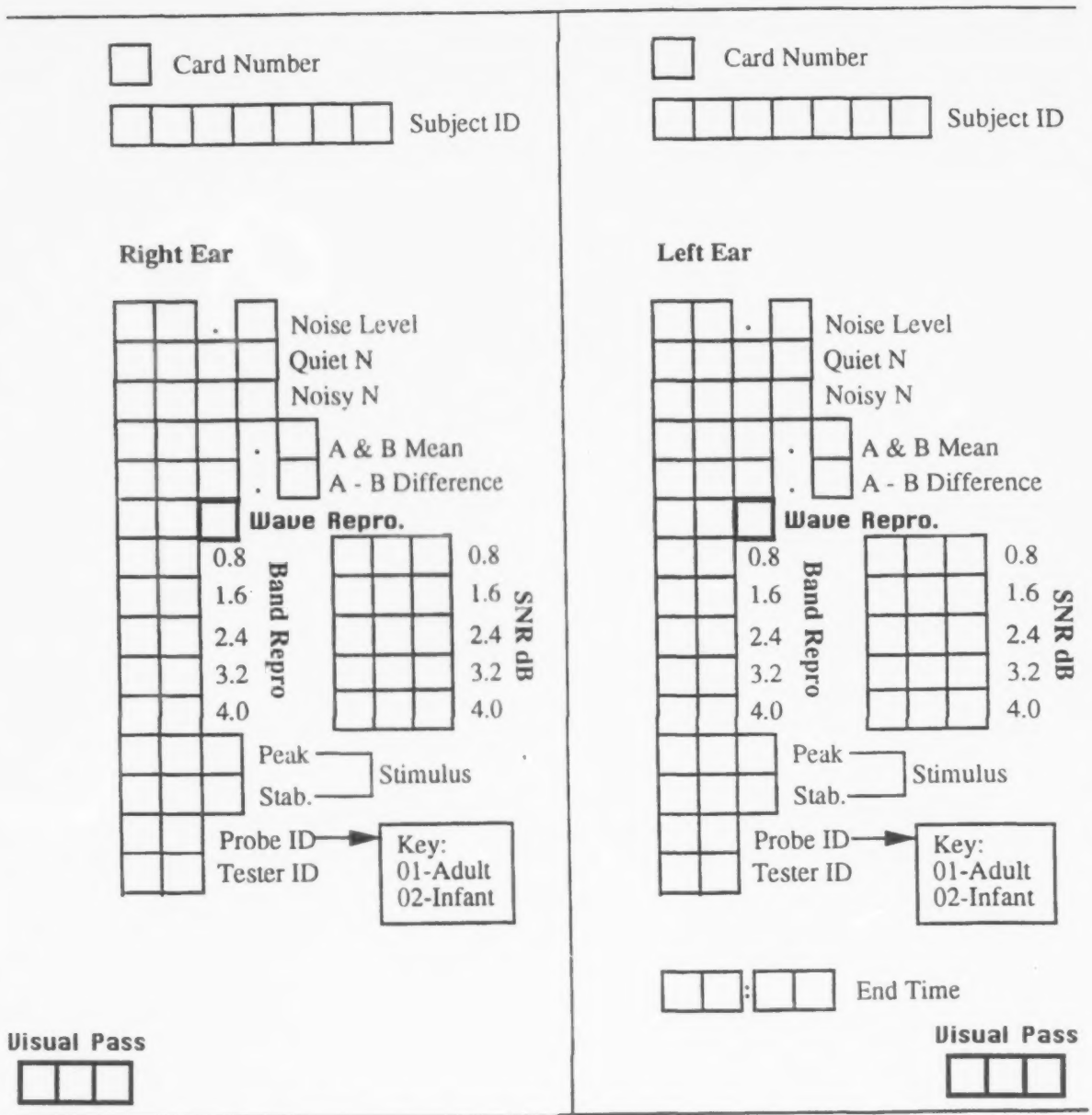
Comments:

PURE-TONE THRESHOLD FORM

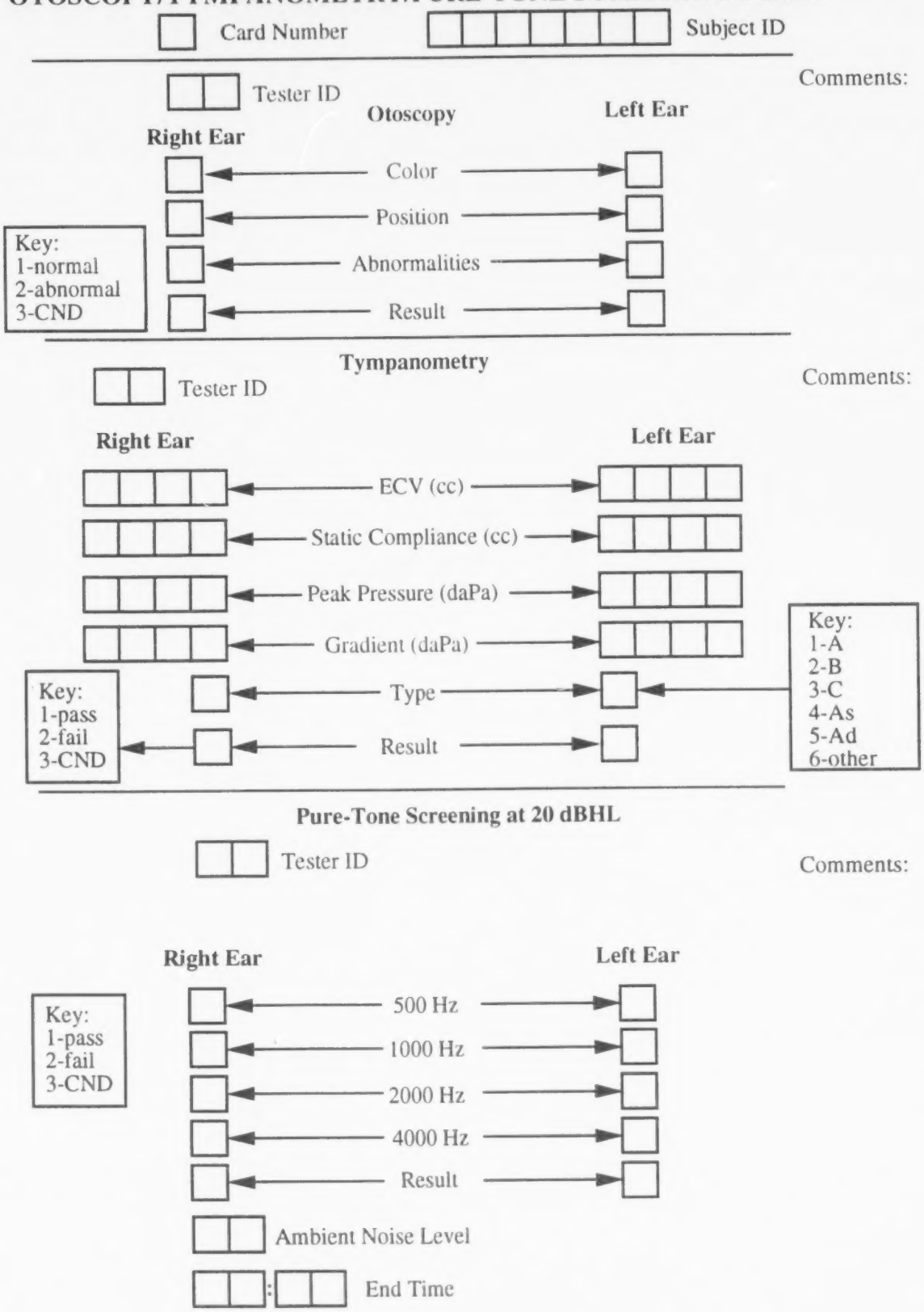


Comments:

OAE SCREEN RESULTS



OTOSCOPY/TYMPANOMETRY/PURE-TONE SCREENING FORM



TEOAE Hearing Screening Project

PARENT INFORMATION QUESTIONNAIRE

This sheet is two-sided. Please provide us with the following information to the best of your knowledge on both sides of this sheet. In our records, this information will only be accessible by an identification number to which no names will be linked.

Child's Name: _____ **Grade:** _____ **Date of Birth:** ___/___/___

Child's Gender (circle): Male Female

Developmental Information

At birth or soon after (1 month), did your child have any of the following (check all that apply and circle when applicable)?

___ **Family history of childhood hearing loss**
___ **Maternal infection such as (please circle all that apply):**

Cytomegalovirus (CMV) *Rubella* *Toxoplasmosis* *Syphilis*

___ **Malformations of the face or outer ear or ear canal**
___ **Birth weight less than 3 lbs., 5 oz.**
___ **Jaundice which required a transfusion**
___ **Bacterial meningitis**

After 1 month of age until present (check all that apply):

___ **Do you or other caregivers have concern about your child's hearing, speech, or language?**
___ **Has your child sustained a head trauma involving loss of consciousness or skull fracture?**
___ **Has your child had any of the following childhood diseases (circle all that apply)?**

Bacterial Meningitis *Mumps* *Chicken Pox* *Cytomegalovirus (CMV)*

Previous Hearing Test Information

Has your child had his or her hearing tested before? ___ Yes ___ No

Were you informed that your child had a hearing problem? ___ Yes ___ No

If the results of the hearing testing indicated that your child had a hearing problem, what were the recommendations, if any, of the person who tested your child's hearing?

_____

_____

**** Please Turn This Sheet Over ****

TEOAE Hearing Screening Project

PARENT INFORMATION QUESTIONNAIRE

(continued)

Ear Infection Information

Is your child prone to frequent ear infections? ___ Yes ___ No

If "Yes," about how many ear infections does your child have per year? _____

When was the last ear infection? _____

How have the infections been treated? _____

_____

In which ear(s) has your child had ear infections?

____ Right Ear ____ Left Ear ____ Both Ears

Has or does your child have PE tubes in his or her ear(s)? ___ Yes ___ No

If "Yes," please check the ear(s) in which your child has had or has PE tubes:

____ Right Ear ____ Left Ear ____ Both Ears

COMMENTS

_____

_____

_____

_____

Thank You For Participating!

Project ID#: _____

PARENT INFORMATION QUESTIONNAIRE
(continued)

Ear Infection Information

Is your child prone to frequent ear infections? ___ Yes ___ No

If "Yes," about how many ear infections does your child have per year? _____

When was the last ear infection? _____

How have the infections been treated? _____

_____

In which ear(s) has your child had ear infections?

____ Right Ear ____ Left Ear ____ Both Ears

Has or does your child have PE tubes in his or her ear(s)? ___ Yes ___ No

If "Yes," please check the ear(s) in which your child has had or has PE tubes:

____ Right Ear ____ Left Ear ____ Both Ears

COMMENTS

_____

_____

_____

_____

Thank You For Participating!

Project ID#: _____

TEOAE Hearing Screening Project

PARENT INFORMATION QUESTIONNAIRE

This sheet is two-sided. Please provide us with the following information to the best of your knowledge on both sides of this sheet. In our records, this information will only be accessible by an identification number to which no names will be linked.

Child's Name: _____ **Grade:** _____ **Date of Birth:** ___/___/___

Child's Gender (circle): Male Female

Developmental Information

At birth or soon after (1 month), did your child have any of the following (check all that apply and circle when applicable)?

___ **Family history of childhood hearing loss**
___ **Maternal infection such as (please circle all that apply):**

Cytomegalovirus (CMV) *Rubella* *Toxoplasmosis* *Syphilis*

___ **Malformations of the face or outer ear or ear canal**
___ **Birth weight less than 3 lbs., 5 oz.**
___ **Jaundice which required a transfusion**
___ **Bacterial meningitis**

After 1 month of age until present (check all that apply):

___ **Do you or other caregivers have concern about your child's hearing, speech, or language?**
___ **Has your child sustained a head trauma involving loss of consciousness or skull fracture?**
___ **Has your child had any of the following childhood diseases (circle all that apply)?**

Bacterial Meningitis *Mumps* *Chicken Pox* *Cytomegalovirus (CMV)*

Previous Hearing Test Information

Has your child had his or her hearing tested before? ___ Yes ___ No

Were you informed that your child had a hearing problem? ___ Yes ___ No

If the results of the hearing testing indicated that your child had a hearing problem, what were the recommendations, if any, of the person who tested your child's hearing?

_____

_____

**** Please Turn This Sheet Over ****

Appendix D: Consultant Report

Mayo Clinic

Rochester, Minnesota 55905 Telephone 507 284-2511

Martin S. Robinette, Ph.D.
Otorhinolaryngology
Audiology

October 11, 1993

Ms. Judith Fein
Project Officer
U.S. Department of Education
7th and D Streets, S.W.
Room 3653
Washington, DC 20407

Dear Ms. Fein:

I spent September 30 and October 1, 1993 at Utah State University, Logan, Utah as a consultant on the grant titled "The Efficacy of Transient Evoked Otoacoustic Emissions in Identifying Hearing Loss in Children with Developmental Disabilities." This project is funded under the Field-Initiated Research Program 84-023C by Karl R. White, Brandt Culpepper and Gary W. Mauk.

During my visit I worked primarily with Brand Culpepper and Gary Mauk and their team including Sherly Spriet, Sara Lee Tidwell and Jeff Larson.

We carefully reviewed the grant proposal and methods being implemented including data collection form and test criteria. Their study is well designed and documented and should provide meaningful sensitivity and specificity data on the use of TEOAEs in hearing assessments of children with developmental disabilities.

Time was spent discussing strategies to hold the attention of these children for the time required to measure the presence or absence of TEOAEs. In an effort to maximize the use of available data and to insure specific criterion for each emission response variable using the IL088 instrumentation, the following procedures were adopted:

- pure tone screening will include 4 frequencies: 1000, 2000, 3000, and 4000 Hz (3000 Hz was added).

- For purpose of validity, at least 60 blocks of pulses must be accepted and averaged (counted as "No Lo" by the IL088).

- To accept an emission as being recorded, the reproducibility must be at least 50% for the 1000 Hz bandwidth in which the emission occurs. In addition the emission amplitude must be at least 3 dB above background noise (A+ B -[A-B]). This second criterion is met by the method of measuring 2 millimeters of blue above the noise level recorded in red.

- To determine the "Noise Reject Level" during testing the computer program will be set to accept the lowerst two-thirds of the emission samples.

- The ambient noise levels (dBA scale) will be measured at each test site at or near the time of TEOAE testing.

I was impressed with both the facilities and staff at Utah State University. They have an excellent working relationship across departments and strong institutional support. The investigators are excited, motivated, thorough, knowledgeable and open. I was delighted to meet with them and now share their excitement and interest in the project.

I hope this information is helpful, If I may provide other information please let me know.

Sincerely,

Martin S. Robinette, Ph.D.
Professor and Section Head

MSR/cjz

cc: Gary Mauk

Appendix E: Data Dissemination Activities

Data Dissemination Activities

Publications in Peer-Reviewed Journals

Culpepper, B. (1993). The feasibility of using otoacoustic emissions in educational audiology. Educational Audiology Monographs, 3(1), 10-14.

Culpepper, B., Spriet, S. Y., & White, K. R. (1995). Use of transient evoked otoacoustic emissions with school-aged children (abstract). American Academy of Audiology 7th Annual Convention Program, p. 19.

Culpepper, B., Spriet, S. Y., Tidwell, S. O., & Mauk, G. R. (1994). Conventional versus TEOAE school hearing screening programs (abstract). Asha, 36(10), 150.

Culpepper, B. (1993). The feasibility of using otoacoustic emissions in educational audiology (abstract). Educational Audiology Association Newsletter, 10(4), 5.

Presentations to National Audiences

Culpepper, B. (1996, March). Anatomy and physiology of otoacoustic emissions; Introduction to using HI*SCREEN and the ILO88; Interpreting hearing screening results; Troubleshooting TEOAE hearing screening sessions with the difficult-to-test; Data management; Use, care, and maintenance of equipment; Clinical possibilities of otoacoustic emissions. TEOAE-Based hearing screening with preschool-aged children. Invited workshop held at the University of Wyoming, Laramie, Wyoming.

Culpepper, N. B. (1995, March). Use of evoked otoacoustic emissions in educational audiology. Invited paper presented to the Educational Audiology Association at the American Academy of Audiology annual convention, Dallas, Texas.

Culpepper, B. (1993). Screening school-aged and developmentally delayed children with transient evoked otoacoustic emissions. Annual meeting of the Technical Assistance Consortium for Universal Newborn Auditory Screening using Evoked Otoacoustic Emissions, Arlington, Virginia.

Culpepper, B., Spriet, S., Y., & White, K. R. (1995, September). Use of TEOAEs in educational settings. Paper presented at the American Academy of Audiology annual convention, Dallas, Texas.

Culpepper, B., Spriet, S. Y., Tidwell, S. O., & Mauk, G. R. (1994, November). Conventional versus TEOAE school hearing screening programs. Paper presented at the American Speech-Language-Hearing Association annual convention, New Orleans, Louisiana.

Culpepper, B., Spriet, S. Y., Larsen, J., & Tidwell, S. O. (1994, August). Use of transient evoked otacoustic emissions for educational management. Paper presented at the Academy of Rehabilitative Audiology Summer Institute, Salt Lake City, Utah.

Larsen, J., Spriet, S. Y., Tidwell, S. O., & Culpepper, B. (1994, May). Clinical application of TEOAEs in an Educational Setting. Paper presented at the Utah Speech-Language-Hearing Association Spring Conference, Park City, Utah.

Culpepper, B., Spriet, S. Y., Mauk, G. W., & Tidwell, S. O. (1994, April). Use of TEOAEs in an Educational Audiology Setting. Paper presented at the American Academy of Audiology Annual Convention, Richmond, Virginia.

Culpepper, B. (1993, July). The feasibility of using otoacoustic emissions in educational audiology. Invited paper presented at the Educational Audiology Associatoin Summer Conference, Logan, Utah.

The Feasibility of Using Transient Evoked Otoacoustic Emissions (TEOAE'S) in Educational Audiology

Brandt Culpepper
Utah State University

Editor's Note: This article is an invited manuscript from a presentation at the 1993 EAA Summer Institute. Although much of this information is available in greater depth in other journals, the topic and application to the practice of audiology in the school setting created considerable interest and discussion at the meeting. Otoacoustic emissions testing is not considered a viable evaluation method within a school setting at this time, but technological advances in the portability of equipment as well as expected reduction in the cost of equipment may allow this procedure to become part of the educational audiology assessment menu in the future. Additional readings are provided in the list of review/tutorial articles at the end of this paper.

Transient evoked otoacoustic emissions (TEOAEs) have great potential to be used in educational audiology. Measurement of TEOAEs is quick (1-2 minutes per ear), non-invasive, and provides the audiologist with an objective measure of cochlear function. At present, TEOAEs may be used in three of the four major areas involved in audiological assessment: (a) screening for auditory pathology, (b) differential diagnosis, and (c) monitoring auditory status. Complete quantification (determining the degree) of hearing loss, however, is not possible with TEOAEs at this time. The use of TEOAEs may assist in improving services offered by educational audiologists in a number of areas. These include, but are not limited to: hearing screening programs for preschoolers, children with developmental disabilities, multiple handicaps, or other special needs; monitoring cochlear status of children with fluctuating or progressive sensorineural hearing loss; differentiating between sensory and neural hearing pathology; and identification of children who present non-organic hearing losses. At present, it may not be feasible for each public school district to provide the equipment necessary for OAE tests.

Since David Kemp's report on the measurement of acoustic echos in 1978, otoacoustic emissions (OAEs) have been refined into a viable clinical tool. At that time, it was already well known that when the external ear canal is stimulated auditorily, the sound moves through the middle ear and into the cochlea. In the cochlea, thousands of hair cells transport the acoustic information from the traveling wave within the cochlea to the eighth nerve, through the brainstem, and up through the central auditory pathways to the brain. Kemp demonstrated that at the same time, the hair cells within the cochlea (since found to be primarily the outer hair cells) also generate energy, called otoacoustic emissions. The mechanical energy created within the cochlea is sent back through the middle ear to the tympanic membrane, which transduces the vibratory into acoustic energy to the external ear canal. By placing a small probe, which contains a transducer and a microphone, into the ear canal, the energy created by the cochlea can be measured, amplified, than averaged and separated from random noise. This information is then analyzed by a microcomputer attached to the probe to determine whether the cochlea is emitting an emission in response to auditory stimulation. The information provided by measurement of otoacoustic emissions allows the audiologist to fill in another piece of the puzzle often presented when trying to determine auditory status. Specifically, otoacoustic emissions provide the only non-invasive information available regarding preneural cochlear function.

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DESCRIPTION OF OTOACOUSTIC EMISSIONS

There are two types of OAEs, spontaneous (SOAEs) and evoked (EOAEs). SOAEs are narrow bands of sound created by the outer hair cells within the cochlea without any intentional acoustic stimulation being delivered to the ear. They are present in about half of the population with normal hearing. Evoked otoacoustic emissions (EOAEs) are created by the normal, healthy cochlea in response to an external auditory stimulus. The various types of EOAEs are classified according to the stimuli used to create the emission or the cochlear response to the stimuli. EOAEs include Transient Evoked OAEs (TEOAEs), Stimulus Frequency OAEs (SFOAEs), and Distortion Product OAEs (DPOAEs). TEOAEs are recorded in response to a click stimulus (similar to ABR), SFOAEs are produced with a continuous pure tone, and DPOAEs are created from the normal nonlinear response of the cochlea to a simultaneous input of two pure tones (F_1 and F_2) separated in frequency in response to the input of the two pure tones.

At present, TEOAEs appear to have the most potential for widespread application in educational audiology. A click stimulus, with a characteristically broad frequency spectrum, is used as a stimulus. Computer software analyzes the responses by Fast Fourier Transform (FFT) and generates a frequency spectrum of the TEOAE, typically between 500-4000 Hz. The frequency spectrum is then observed to determine the presence or absense of a response. Figure 1 presents examples of present, partially present, and absent TEOAE responses. TEOAEs may be recorded in essentially all ears with normal hearing but are generally absent in the presence of a 30-35 dB HL hearing loss.

CLINICAL USES OF TEOAES

Tools and tests of audiometric assessment generally fall into one of four use categories: screening, differential diagnosis, quantification, and monitoring. Each of these categories will be defined and the feasibility of using TEOAEs for each will be discussed in the following sections. In general, TEOAEs may be used for each of these purposes with the exception of quantification.

Screening

Audiometric screening procedures produce a pass/fail result. No information is provided regarding nature, degree, or status of the hearing loss. They are simply used to determine if further testing is warranted. Perhaps the most widespread use of TEOAEs at this time is as a screening tool for identifying neonates and infants who need further testing to rule out the presence of a sensory or conductive hearing loss. TEOAEs may also hold a place in hearing screening programs in educational audiology as well. TEOAE tests are non-invasive, fast, objective, easy to administer, and easily interpreted. The probes used to measure TEOAEs are typically less invasive than those used in auditory brainstem response measurements. Results may be obtained in less than one minute per ear and do not require special patient preparation procedures, although otoscopy is necessary prior to insertion of the probe into the ear canal. The results generated from the FFT are objective and do not require much voluntary particpation or cooperation of the child being tested.

As such, TEOAEs may be used to screen for hearing loss in many populations that have traditionally been considered "difficult-to-test" using conventional pure-tone screening procedures in school systems. Some of these may include preschool-aged children, children with developmental disabilities, children with multiple handicaps, or children with other special needs.

In addition, little training is needed in order to teach assistants or technicians to obtain test results. Although data interpretation is preferred to be completed by an audiologist, the test may be run by paraprofessionals, nurses, aides, or volunteers who have been trained to operate the equipment. Under these circumstances, differentiation between a "good" from a "bad" run is taught. If a "good" run is obtained, the other ear (or the next child) may then be tested. If the test results in a "bad" run, the test is repeated. All test results are stored on the computer being used with the system for future reference and interpretation.

Since the presence or absence of a TEOAE is easily identified. interpretation of screening test results is fairly straight forward. The criteria that many are using to determine test validity and a pass from a fail are those which have been recommended by Daivd Kemp: (a) peak stimulus between 71 and 83 dB SPL; (b) stimulus stability 75% or greater; and (c) reproducibility 75% or greater. Criteria for a pass include the presence of a response (recorded in blue on the computer screen) which is clearly visible above the noise floor (recorded in red on the computer screen) for at least one-half the distance across each of three frequency bans (1-2, 2-3, and 3-4 kHz).

To date, however, no normative data on TEOAEs in children are available in the published literature. This is due, in part, to the high intersubject variability present in TEOAE measures. In addition, TEOAE responses have been found to differ with gender, age, middle ear status, noise levels (ambient and internal), and ear being tested, with the right ear having a slight advantage. Females have shown slightly higher response amplitudes than males (Robinette, 1992). In addition, TEOAE response amplitude appears to decrease with increasing age (Robinette, 1992). Middle ear status has been shown to reduce overall TEOAE amplitudes or obliterate measurement of the cochlear response entirely (Orlando & Walton, 1991; Owens, McCoy, Lonsbury-Martin, & Martin, 1992).

One study which has been conducted solely on school-aged children using TEOAEs was conducted by Nozzas and Sabo (1991). Their study had two primary aims. The first aim was to obtain TEOAE measures on school-aged children with no evidence of middle ear pathology or hearing loss in an attempt to obtain some normative data. They concluded that, due to high intersubject variability, additional research is needed prior to developing normative data for TEOAEs. The second aim was to determine if using specific TEOAE variables as part of a screening protocal was comparble to, or an improvement on, existing screening protocols (ASHA 1990 Guidelines). They concluded that the TEOAE test met the criteria for acceptability and that although single TEOAE measurers had high false-positive rates, those rate were similar to those found with the ASHA screening protocol.

Differential Diagnosis

Procedures used for making a differential diagnosis allow the audiologist to make a distinction between various types of conditions, such as between a conductive or a cochlear pathology. For instance, a flat typmanogram allows the clinician to determine the presence of a middle ear/conductive pathology. OAEs are the only non-invasive test in the audiological battery which are specific to pre-neural cochlear activity. Since many auditory pathologies arise from damaged cochlear tissue, OAEs are rapidly becoming a part of the basic clinical battery of tests administered to determine site of lesion in the presence of an auditory pathology.

In addition, TEOAEs may assist in identifying the malingering individual. If a significant hearing loss is presented and TEOAE responses are observed, a non-organic type of hearing loss may be present. One note of caution which must always be addressed, however, is that the presence of a TEOAE response cannot be generalized into a statement regarding normal hearing. The measurement itself comes from the cochlea and does not in any way address an indivdual's ability to process the auditory information present in the peripheral auditory mechanism.

Quantification

Quantification procedures allow for determining the degree of hearing loss in an objective, sensitive, and frequency-specifc manner. Although TEOAEs are objective, sensitive, and frequency specifc, they cannot determine the degree of hearing loss. TEOAEs typically cannot be measured from ears where hearing thresholds exceed 30-35 dB HL regardless of the degree of hearing loss. If

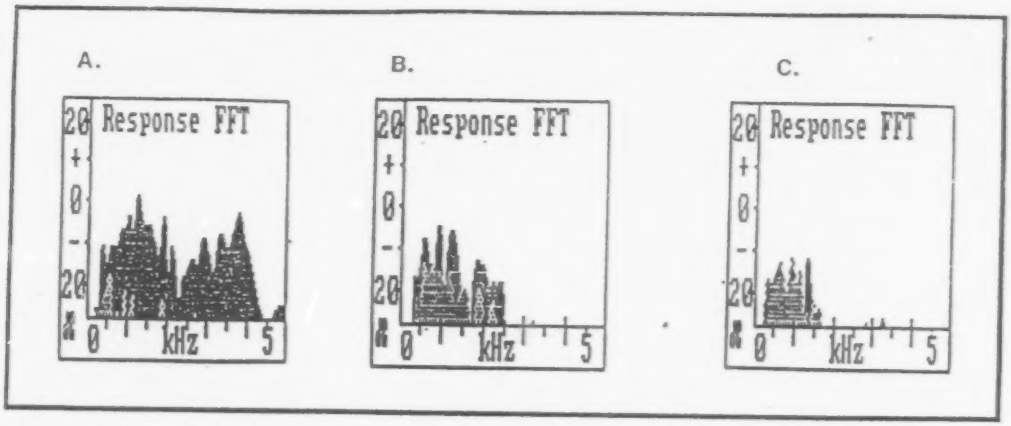

Figure 1. Examples of a Pass (A), a Partial Pass (B), and a Fail (C) TEOAE response. Response spectra are designated in black while the nosie floor is illustrated in the crosshatch.

a broad-band TEOAE response is present, however, it may be assumed that the outer hair cells along the cochlear partition representative of those frequencies are functional. On the other hand, in the presence of a hearing loss, the response spectrum is limited. In Figure 1, the response spectra presented by response A was recorded from an individual with normal hearing while response B was obtained from an individual with a high frequency sensory hearing loss. The absence of energy in the high frequency region is suggestive of dimninished cochlea function in the high frequency region. Pure tone thresholds for this individual were normal through 2000 Hz and dropped to 35, 35 and 50 dB HL for 3000, 4000, and 8000 Hz, respectively.

Monitoring

Although a great deal of intersubject variability exists in measurement of TEOAEs, responses recorded from an individual over time remain essentially stable as long as cochlear function remains stable (Norton, 1993). TEOAEs may therefore be used effectively to monitor the status of the cochlea in individuals receiving ototoxic drug therapy, with fluctuant sensory hearing losses, or to monitor the effects of noise exposure. In some instances OAE measures are more sensitive to cochlear dysfunction than are pure tone thresholds.

TEOAE TESTING IN AN EDUCATIONAL ENVIRONMENT

The Department of Communicative Disorders and the Department of Psychology at Utah State University are currently working on a grant entitled "The Efficacy of Transient Evoked Otoacoustic Emissions in Identifying Hearing Loss in Children with Developmental Disabilities." The primary goals of this project are (a) to identify hearing loss in children (aged three to seven years) with confirmed disabilities using traditional audiometric screening and assessment procedures combined with TEOAE testing; and (b) to compare the sensitivity and specificity of conventional screening programs in a group of children without disabilities and a group of children who have been identified as having one or more disability. Although only in the initial stages of the three-year project it has become readily apparent that TEOAE tests may be completed in an efficient manner within an environment typical to one used for conducting pure tone and/or tympanometric screenings. Although ambient environmental noise affects TEOAE measurement, more difficulty may be encountered from internal noise within the child being tested than from ambient noise levels, particularly for young children and children with developmental disabilities. As such, we have found that using visual or tactile distractors similar to those sometimes used to obtain immittance measures (e.g. — toys, puppets, etc.) may imporve test efficiency. We are also experimenting with the use of a silent videotape player as a distractor.

CASE STUDY: TEOAES PROVIDE USEFUL INFORMATION

Nathan, a 19-year-old male with severe handicaps, was referred to the Speech-Language-Hearing Center at Utah State University for a complete audiological assessment by the audiologist in his school district. Nathan presently is attending high school in a special education classroom. The audiologist's referral reported that the district was in the process of classifying Nathan deaf/blind. Although the audiologist did not have the instrumentation necessary to determine Nathan's complete audiological status, behavioral observations suggested that he had some degree of hearing and was not deaf.

Case history information obtained from Nathan's mother on the test date revealed that he was born prematurely and was hospitalized for seizures after birth. The cause of his seizures is unknown, and he is presently on medication to control them. She reported that she feels that Nathan hears but responds inconsistently to sound. He responds to verbal commands on occasion, enjoys listening to his wind-up radio or the television, and rarely misses the sound of opening a candy wrapper. Nathan communicates primarily through gestures and minimal signs, but does not communicate verbally. During the case history, Nathan was able to visually track a brightly colored object with no apparent difficulty.

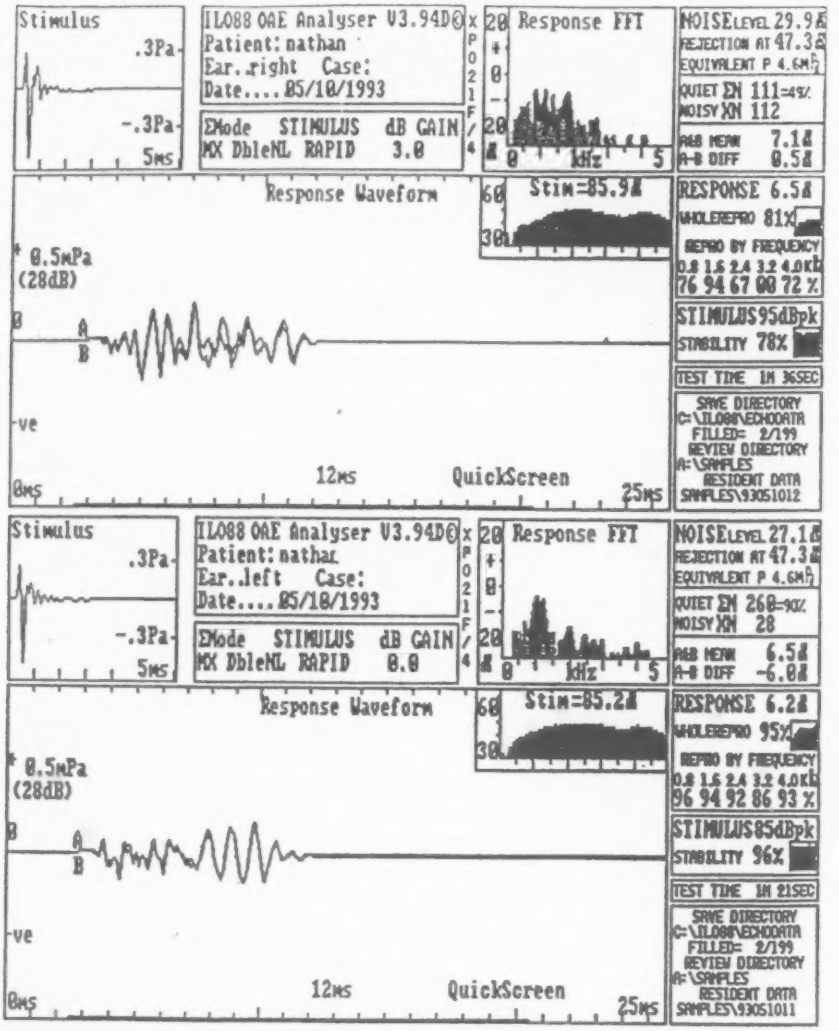

Figure 2. TEOAE screening data obtained from Nathan. Response spectra are presented in black while noise floor spectra are crosshatched. Nathan passed the hearing screening in each ear.

Audiometric test results indicated normal immittance measures when screened in both ears, suggesting no middle ear pathology. Ipsilateral acoustic reflex thresholds at 1000 Hz were present at 95 dB SPL bilaterally. Using Visual Reinforcement Audiometry, inconsistent responses to 2000 and 4000 Hz warble tones were observed at 20-40 dB HL. A soundfield speech detection threshold of 20 dB HL was observed. Therefore, only minimal information was available from the single test session with Nathan using conventional audiometric procedures.

Additional information from TEOAE measurement was obtained in less than five minutes of total test time. Nathan passed the TEOAE screening in each ear (see Figure 2), suggesting that cochlear function was normal bilaterally, These data, combined with the immittance and behavioral data, were enough for the audiologists to comfortably rule out the presence of an educationally significant hearing loss in either ear.

FUTURE DIRECTIONS OF TEOAES IN EDUCATIONAL AUDIOLOGY

At this time, it may be unrealistic to expect that each school district provide the equipment and training needed by educational audiologists to perform TEOAE tests. At this writing, the cost of the equipment necessary for performing TEOAE measures is approximately $10,000, which makes it cost-prohibitive for most school systems. In addition since the measurements are made with the assistance of a computer, transporting the equipment from one location to another is somewhat cumbersome. It is anticipated that

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future technological advances will greatly diminish the size of the instrumentation and that truly portable devices will become available. It remains imperative, however, that educational audiologists understand the fundamentals of these tests, the information provided by the test, and the basics of interpreting test results.

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REVIEW/TUTORIAL ARTICLES ON OTOACOUSTIC EMISSIONS

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December 22, 1993

Brandt Culpepper, Ph.D.
Department of Communicative Disorders
Utah State University
Logan, Utah 84322-1000

Dear Brandt:

The AAA Instruction Course committee is pleased to inform you that your course, 94-173, Use of TEOAEs In An Educational Audiology Setting has been accepted to the 1994 Convention. The date and time for this ONE HOUR course is Saturday, April 30, 1994 from 1:00-2:00 p.m. Room assignments have not been made and that information will be forwarded later.

I am enclosing some information that should be helpful for your preparation. Thank you for your support and commitment to the Convention Program.

Sincerely,

Mike

J. Michael Dennis, Ph.D.
Chairman, Instructional Course Committee

JMD:llh

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Caring for America's Hearing
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AAA 1994 INSTRUCTIONAL COURSE PROPOSAL

Course Title: Use of TEOAEs in an Educational Audiology Setting
(60 Character Limit)

Primary (Corresponding) Instructor:

Name/Degree (1) Brandt Culpepper, Ph.D., CCC-A Academy Member X Yes ___ No

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Co-Instructors

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Academy Member ___ Yes X No

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Logan, Utah 84322-1000
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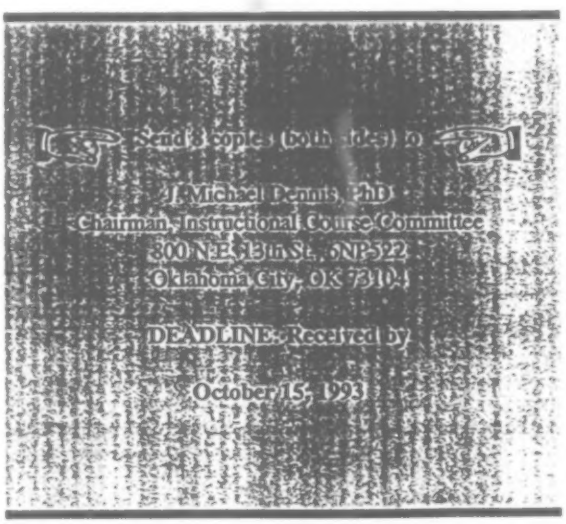
EQUIPMENT

Standard equipment per room:

1 Carousel Slide Projector with trays and Remote Control
1 Projection Screen
1 Microphone
1 Electric Pointer

Special Requirements _____


Send 3 copies (both sides) to
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October 15, 1993

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Use of TEOAEs in an Educational Audiology Setting

American Academy of Audiology
Annual Convention 1994

Culpepper, Spriet, Mauk, & Tidwell

Scope of the Problem

*32 to 78% of children with disabilities have some degree of hearing loss

*Children with disabilities are often "difficult to test"

*Late, nonexistent, or misdiagnosis can result in inappropriate educational placement

USU

Purpose

- Discuss the feasibility of using TEOAEs to screen for hearing loss in educational settings
- To compare conventional school screening results to TEOAE screening results
- To discuss practical aspects of using TEOAEs in an educational setting

USU

TEOAEs for Children with Developmental Disabilities

Objectives

- **Identify hearing loss in children with identified developmental disabilities**
- **Compare sensitivity and specificity of conventional and TEOAE hearing screening procedures**
- **Compare cost effectiveness of conventional versus TEOAE hearing screening techniques**

USU

Subjects in Regular Educational Programs

- 287 public school children aged 3 to 7
- No known disabilities
- Receiving no special services through the school system
- Parental consent for participation

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Limitations of TEOAEs

- Does not yield threshold data
- Equipment expense
- Portability
- Provides preneural auditory information only

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Technical Advantages of TEOAEs

- **Simple**
- **Non-invasive**
- **Objective**
- **Efficient**
- **Sensitive**
- **Frequency Specific**

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Focal Areas of Audiological Assessment

- Screening for auditory pathology
- Differential diagnosis
- Monitoring auditory status
- Quantification of hearing loss

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TEOAEs in Audiological Assessment

- Screening for hearing loss
- Differential diagnosis
- Monitoring auditory status
- Quantification of hearing loss

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Additional Data

- **Duration of screening**
- **Ambient noise levels**
- **Type of disability**
- **Presence of risk indicators for hearing loss**
- **History of middle ear involvement**
- **Presence of previously identified hearing loss**

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Data Collection

- Otoscopy
- Tympanometry
- Pure tone screening
- Pure tone thresholds
- TEOAEs

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TEOAE Screening Procedures

- Patient data
- Probe placement
- Adjust stimulus gain
- Begin screening using "Quickscreen" option
- Termination of screening
  - minimum of 60 quiet averages
  - whole wave reproducibility 50% or greater
  - response present within 3 octave bandwidths

USU

Judgement of Test Validity

- **Peak stimulus between 77 to 83 dB SPL**
- **Stimulus stability 75% or greater**
- **Minimum of 60 quiet averages for ears with observable pass responses**

USU

Problems Encountered During TEOAE Screenings

- Internal and external noise levels
- Probe fit
- Active children
- Excessive cerumen

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Judgement of Test Validity (cont.)

- **Default (260) test conclusion when response is not a pass**
- **Flat stimulus spectrum of approximately 40 dB SPL or greater from 1000 to 4000 Hz**

USU

Hints for Controlling Noise

External Noise

- Check probe fit
- Decrease ambient noise level
- Turn test ear away from noise source
- Enable low frequency filter

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Hints for Controlling Noise

Internal noise

- Open/close mouth when breathing

- Improve probe fit

- Enable low frequency filter

- Reduce activity level

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Hints for Decreasing Activity Level

- Engage child's attention
- Use visual distractors
- Use tactile distractors

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Hints for Improving Probe Fit

- Positioning!
- Use largest tip that will fit in ear
- Use Huggie Headband to support cords
- Move cords away from body
- Use infant probe (stimulus changes)

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Hints for Testing Children with Excessive Cerumen

- Readjust probe position

.???

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TEOAE Results for Children Without Disabilities

	Left Ear	Right Ear
A&B Mean	9.65 dB SPL	10.47 dB SPL
Whole Wave Repro	63.19 %	63.4 %

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TEOAE Results for Children Without Disabilities

	Left Ear	Right Ear
Quiet	**137.97**	**136.71**
Noisy	**77.93**	**88.53**
Noise Level	**34.81 dB SPL**	**35.57 dB SPL**

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TEOAE Results from Children Without Disabilities

	Left Ear	Right Ear
Stimulus Stability	**94.02 %**	**93.85 %**
Stimulus Peak	**80.55 dB SPL**	**80.07 dB SPL**

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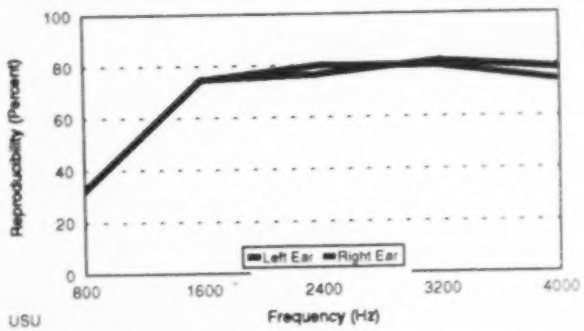
TEOAE Reproducibility by Frequency for Children Without Disabilities



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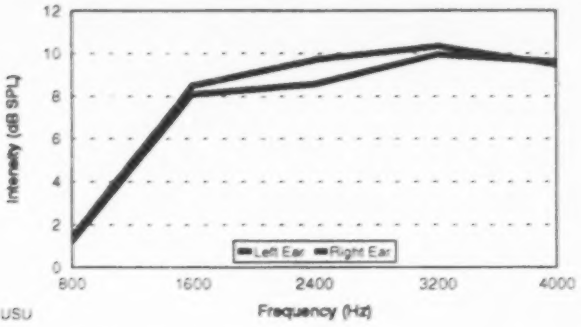
TEOAE Intensity by Frequency for Children Without Disabilities



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Preliminary Conclusions

- TEOAEs may be easily obtained from school-aged children in educational settings
- Conventional pure tone / immittance screenings are more efficient than TEOAE screenings with school-aged children

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Average Duration of Screening Procedures for Children Without Disabilities

	Test Time*
Pure Tone	56 seconds
TEOAE	4 minutes 48 seconds

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*p < .0001

Preliminary Conclusions (cont.)

- For some children, TEOAEs may provide information that cannot be obtained in traditional educational screening settings
- TEOAEs may be used to supplement behavioral test results

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Appendix F: Summary of Participants

District	Schools	Forms[1] Sent	Tested		
			Children w/o Disabilities	Children w/ Disabilities	
Logan					
	*Wilson		33		
Cache					
	*Lincoln		249	29	29
	*Wellsville				
	*River Heights				
Jordan					
	Copperview	7		7	
	West Jordan	13		11	
	Ridgecrest	6		6	
	Butler	2		2	
	East Midvale	3		3	
	Heartland	7		6	
	Riverside	14		7	
	Jordan Valley	42		32	
	Mt. Shadows	2		2	
	Oquirrh	21		21	
	Oakdale	3		3	
	Sprucewood	9		8	
	Canyon View	4		4	
	Bellview	4		4	
	Sandy	4		3	
	*Majestic	-		48	
	*Midvale	-	109	32	199
Weber					
	North Park	28		27	
	Club Heights	13		10	37
Ogden					
	Preschool	60		79	79
Davis					
	Crestview	5		5	
	Monte Vista	4		3	

[1]No forms were collected in schools wherein the data were collected in conjunction with the ongoing school hearing screening programs. Data were collected as part of the mass screenings for every child. These schools are designated with an asterisk (*).

	South Clearfield		7			5	
	Holt		16			13	
	Fremont		6			6	
	Wood Cross		9			9	
	Holbrook		4			4	
	Meadowbrook		2			2	
	Layton		8			6	
	Cook		2			2	
	Antelope		5			5	
	King		10			10	
	Whitesides		6			4	
	Oakhill		5			5	
	Preschool		33	184		21	100
Alpine							
	Cedar Valley		9			9	
	Lehi		3			3	
	Barrat		2			2	
	Manila	6			6		
	Northridge		10			10	
	Highland		5			5	
	Forbes	3			3		
	Valley View		5			5	
	Bonneville		1			1	
	Windsor		7			7	
	Scera Park		1			1	
	Peterson		3			3	
	Alpine		1			1	
	Shelley		1			1	
	Cascade		11			11	
	Meadow		3			3	
	Orem		1			1	
	Sego Lily		3			3	
	Westmore		1			1	
	Grovecrest		5			5	
	Sharon		6			6	
	Geneva		5			5	
	Greenvwood		9			9	
	Orchard		6			6	
	Hillcrest		8	600		8	114
Box Elder							

	*Mountain View			29		
	*Central			11		
	*Bear River			10		
	*McKinley			9		
	*Lincoln			10		
	*Foothill				9	
78						
Granite						
	Freemont	12		10		
	Pleasant Green	10		9		
	Hartvigser	1		1		
	Moss	9		8		
	Mill Creek	7		7		
	Pioneer	5		4		
	Libby Edward	1		1		
	Redwood	6		6		
	Silver Hills	10		9		
	Orchard	15		15		
	Hillside	11		9		
	North Park	21		20		
	Hunter	9		8		
	Vista	9	205	9	97	
Provo						
	Canyon Crest			9		
	Franklin			2		
	Edgemont			5		
	Grandview			5		
	Wasach	72		2	25	
	*Utah School Deaf/Blind			7	7	
Total			**352**	**765**		